PB82-166356

Draft Environmental Impact Statement Underground Injection Control Program Proposed Regulations (40 CFR Part 146)

(U.S.) Environmental Protection Agency
Washington, DC

1976

U.S. Department of Commerce
National Technical Information Service
NTIS

PB82-166356

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

STATE UNDERGROUND INJECTION CONTROL PROGRAM

PROPOSED REGULATIONS
(40 CFR PART 146)

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

Prepared by

OFFICE OF WATER SUPPLY
U.S. ENVIRONMENTAL PROTECTION AGENCY

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO.

2.

3. Recipient's Accession No.
PB82 166356

4. Title and Subtitle
Draft Environmental Impact Statement
State Underground Injection Control Program
Proposed Regulations (40 CFR Part 146)

5. Report Date
1976

6. 053025

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
U.S. Environmental Protection Agency
Office Of Water Supply
Washington, D.C.

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

This Environmental Impact Statement (EIS) was prepared by EPA to explain the background of the proposed action and the rationale that was used in developing the regulations. It discusses in detail the anticipated benefits that will result from implementation of the regulations and compares them with the adverse impacts that cannot be avoided.

17. Document Analysis. a. Descriptors
Groundwater
Aquifers
Underground
Waste Disposal
Water Supply

b. Identifiers/Open-Ended Terms
Environmental Impact Statement
Safe Drinking Water Act
Regulations
Economic Impact

c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report)

20. Security Class (This Page)

21. No. of Pages
161

22. Price

(See ANSI–Z39.18)

See Instructions on Reverse

OPTIONAL FORM 272 (4–77)
(Formerly NTIS–35)
Department of Commerce

DRAFT

ENVIRONMENTAL IMPACT STATEMENT
ON UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
(40 CFR PART 146)

STATE UNDERGROUND INJECTION CONTROL PROGRAM

PROPOSED REGULATIONS

Prepared by

OFFICE OF WATER SUPPLY

U. S. ENVIRONMENTAL PROTECTION AGENCY

Victor J. Kimm

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Office of Water Supply

SUMMARY

DRAFT ENVIRONMENTAL IMPACT STATEMENT,
ENVIRONMENTAL PROTECTION AGENCY

1. Type of Action:

   Regulatory.

2. Brief Description of Action:

   The proposed action prescribes a new set of regulations which sets minimal standards for State programs to prevent underground injection which endangers underground sources of public-water supplies. The regulations have been issued in conformance with the requirements of P.L. 93-523 (the Safe Drinking Water Act), which amends the Public Health Service Act.

3. Summary of Beneficial and Adverse Environmental Effects:

   a. Improved protection of public health is provided by bringing dangerous sources of contamination of underground drinking-water sources under minimal nationwide requirements for control.

   b. High flexibility allowed States in developing programs which would be consistent in part with present regulatory procedures.

   c. Implementation of the program should not be excessively costly to the States and most injectors.

   d. Differences in programs from State to State will result in some lack of uniformity in procedures across the nation.

   e. Some injectors will encumber increased costs in meeting the regulatory requirements or in developing alternative methods of disposal of contaminated fluids.

   f. Further degradation of the quality of ground water will occur where it cannot be demonstrated that injection endangers drinking-water supplies.

4. Alternatives Considered:

   a. No action.

   b. Non-restrictive regulations.

   c. Restrictive regulations.

5. Federal, State, and Local Agencies from Which Comments Have Been Requested:

See Attachment I.

6. Date to CEQ and Public:

Draft:

Attachment I

Federal

Department of Agriculture
  Soil Conservation Service

Department of Commerce

Department of Defense
  Army Corp of Engineers

Department of Interior
  Bureau of Indian Affairs
  Bureau of Land Management
  Bureau of Sport Fisheries and Wildlife
  Geological Survey
  Office of Oil and Gas
  Office of Saline Water

Energy Research and Development Administration

Federal Energy Agency

Federal Power Commission

Water Resources Council

State

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Interested Parties

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Arne Gubrud, American Petroleum Institute

Seth Abbott, American Petroleum Institute

Frank Wood, Salt Institute

Richard Nalesnik, National Association of Manufacturers

James Miller, Freeport Sulfur

George Hugo, Texasgulf Sulfur

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Richard Pearl, National Water Well Association

Robert Harris, Environmental Defense Fune

Diane L. Donley, Natural Resources Defense Council

Linda M. Billings, Sierra Club

Peter L. Sullivan, National Wildlife Federation

Robert Balmer, Dupont de Nemours

Manufacturing Chemists Association

Ohio River Sanitation Commission

American Mining Congress

League of Women Voters

PREFACE

For many years, a wide variety of underground injection practices have been allowed throughout the country that in one way or another have introduced contaminants into aquifer systems used for drinking-water supplies. Control of these practices, which include the disposal of fluid wastes into shallow and deep wells, pits, lagoons, and other kinds of excavations, has not been dealt with adequately by prior State or Federal laws and regulations. Consequently, although some States have attempted to exercise some form of control over these practices, there is no uniformity across the nation in coping with the magnitude and effects of the problem.

Public Law 93-523, known as the Safe Drinking Water Act, was enacted by Congress on December 16, 1974, to insure minimum protection of underground drinking-water sources from contamination by well injection practices. Under the terms of the Act, the Environmental Protection Agency was instructed to issue a set of regulations specifying minimum requirements for State programs to control underground injection of fluids that threaten the quality of water in aquifers used for public supply.

This Environmental Impact Statement (EIS) was prepared by EPA to explain the background of the proposed action and the rationale that was used in developing the regulations. It discusses in detail the anticipated benefits that will result from implementation of the regulations and compares them with the adverse impacts that cannot be avoided. In developing the regulations, EPA considered a number of alternative approaches and rejected those whose environmental, physical, economic, or legal consequences were unacceptable.

Although total control and elimination of all ground-water contamination is not practicable at this time and also is not specifically called for under the language of P.L. 93-523, the present regulations constitute a first major step toward bringing under control many practices and sources of ground-water contamination that endanger public health.

This Environmental Impact Statement was prepared during the period July through November 1975 by EPA with assistance from ground-water consultants experienced in the field of ground-water contamination. An extensive review was made of relevant Congressional hearing documents, previous laws and regulations, and published reports and articles relating to ground-water contamination problems. Contacts were made with selected State agencies and with private organizations for preliminary responses and reactions to the early drafts of the regulations and to provide background information on the types of impacts that might be anticipated. Limitation of time and funds made it impossible to make a quantitative analysis of all the impacts of the regulations, particularly the economic effects. Substantial reliance on judgment, assumptions, and experience was necessary where data were either nonexistent or were not readily available.

Benefits to public health from improved protection of ground-water quality are anticipated from implementation of the regulations and, in addition, individual States will acquire greater capability in controlling sources of underground contamination. Implementation of the regulations will also be instrumental in abating the problem of contamination of the nation's underground drinking-water supplies by directing the attention of injectors and of various levels of government to the serious potential danger of uncontrolled underground injection.

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I. BACKGROUND AND DESCRIPTION OF THE PROPOSED ACTION

A. Introduction

1. General Comments and Public Health Considerations. On December 16, 1974, the Safe Drinking Water Act (P.L. 93-523) to amend the Public Health Service Act (the Act) was signed into law. Section 1421 of the Act authorizes the Environmental Protection Agency (EPA) to issue Federal regulations (see draft in Appendix) concerning State Underground Injection Control Programs (UIC Programs), and requires the programs implemented by the States to meet certain minimal criteria specified by EPA. Each State is to exercise primary responsibility for the protection of underground sources of drinking water, and is to prohibit, within three years after the date of the enactment of the Act, any underground injection which is not authorized by a permit or rule issued by the State.

The entire thrust of the Safe Drinking Water Act and of Section 1421 is to minimize or prevent threats to public health from underground drinking water sources contaminated by man's activities. The Act applies only to public water-supply systems having at least 15 service connections or serving at least 25 persons. Thus, the Act and the underground injection control regulations do not have as objectives protection from contamination of all ground-water sources. Rather, the goal is to protect and improve the quality of drinking water for the large number of people who are served by public water-supply systems, and it is expected that the provisions of the regulations will go far toward accomplishing this goal.

As the program becomes fully implemented, the States, with EPA guidance, will focus attention on facilities now injecting fluids into aquifers that are now or will be used in the future as public water-supply sources. This new level of control should greatly reduce incidences of waterborne diseases and other threats to public health, and will result in an improved standard of drinking-water quality for all people served by public-supply systems.

The specific contents of contaminated ground water that can affect public health can be grouped into five categories: bacteria, parasites, viruses, inorganic chemicals, and organic chemicals. Some recent waterborne epidemics of bacterial origin in the United States that involved a significant number of people were caused by Salmonella typhimurium. Numerous other bacterial diseases have been transmitted by water, but usually the incidence of resulting cases is relatively limited. Parasites are rarely responsible for waterborne diseases in the United States, and indicator bacteria are generally used to determine the quality of water with respect to parasite content or threat to health. The tolerance for numbers of viruses present in water is probably lower than for bacteria. Virus monitoring is difficult and little has been done in actual field situations to date. Advances in water virology, however, suggest that methods for detection and understanding of the significance of viruses in relation to health problems is improving.

The types of waterborne diseases that have resulted in the United States from contamination of public-water supplies include: gastroenteritis, infectious hepatitis, shigellosis, and chemical poisoning (AWWA Water Quality Div. Comm., 1975). An idea of the magnitude of waterborne diseases in the nation can be obtained from Table 1 , which lists known outbreaks and cases due only to contamination of public-water supplies from ground-water sources. These data are drawn from two recent studies of waterborne diseases (Craun and McCabe, 1973; Craun and Hughes, 1975).

Table 1. KNOWN INCIDENTS OF WATERBORNE DISEASE IN THE UNITED STATES DUE TO CONTAMINATION OF PUBLIC-WATER SUPPLIES FROM GROUND-WATER SOURCES
(after Craun and McCabe, 1973 and Craun and Hughes, 1975)

Period	Outbreaks	Cases
1946-70	13	24,251
1971-74	5	74
Total	18	24,325

Numerous inorganic chemicals found in ground water affect human health. These include, for example, toxic substances such as arsenic, heavy metals such as chromium, cadmium, lead and zinc, and nitrates. The sodium content of water is of concern to persons with hypertension problems. Finally, in the case of organic chemicals, the presence of even small amounts in ground water is a matter of great concern to health officials. Gross indicators of organic contamination of water, such as Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), provide only preliminary information compared to detailed analyses which give specific names and concentrations of organic constituents. Public attention has recently been focused, for example, on carcinogens in drinking water as a result of surveys by EPA of selected municipal water supplies (Office of Toxic Substances, 1975). There are hundreds of chemicals (mostly organic) that are presumed to be carcinogenic to man because they are carcinogenic to animals (Harris, 1975). Sources of these carcinogens in water include effluents from the organic chemical industry (benzene, aromatic amines, etc.), inorganic chemical industry (arsenic, asbestos, etc.), petroleum and coal products industry (coal, tar, PAH, benzene, etc.), nuclear reactors and uranium mining, agricultural use of pesticides (dieldrin, arsenic, chlordane, etc.), urban runoff (asbestos, PAH, oils, benzene, etc.), and sanitary landfills (PCB, selenium, and other heavy metals).

The draft regulations are based on an interpretation of the meaning of the term "underground injection" indicated by the content of the hearings and working sessions (House Reports 92-24, 93-11, 93-1135) preceding the final version of P.L. 93-523. From these documents, it is clear that Congress intended to protect ground-water sources against certain but not all types of underground injection practices. Under the present interpretation of the language of P.L. 93-523, as indicated by the UIC Regulations, underground injection is the introduction into the ground of fluids through waste disposal and engineering wells, injection wells related to oil and gas production, and urban runoff and agricultural drainage wells, as listed in Table 2, and discussed in later sections of this report.

This Environmental Impact Statement (EIS) has been prepared to evaluate (a) the intent and purpose of the regulations pertaining to State UIC programs, (b) the reasoning process that was followed in developing the language of the regulations, and (c) the beneficial and adverse impacts that are expected to follow from implementation of the regulations. The EIS gives special emphasis to the impact of underground injection control on public health, state institutions, the owners and operators of injection facilities, and the natural environment.

2. Purposes of Underground Injection. Injection of fluids into underground water sources is practiced widely in the United States. In many instances, the injection is deliberate, in the sense that it is intended as a means of getting rid of fluids at a lower cost than by other methods or is an environmentally safer alternative.

The principal categories of underground injection that are specifically required to be brought under control by the regulations, (a) through (e), are listed below:

(a) disposal of brines and injection of brines or other fluids for secondary recovery purposes in connection with the production of oil and gas;

(b) disposal of storm runoff water, typically from paved urban areas;

(c) disposal of industrial waste fluids through wells, generally into deep brackish or saline-water zones;

(d) subsurface injection of fluids through wells for such purposes as control of salt-water intrusion, artificial recharge, solution mining of ore bodies, and control of land subsidence;

(e) underground storage of natural gas or other substances.

3. The Current Situation. Contamination of ground water stemming from man's activities on or below the land surface is widespread in the United States, according to results of completed or on-going regional summary studies of contaminated ground water by EPA (Miller and others, 1974; Van der Leeden and others, 1975; Fuhriman and Barton, 1971; and Scalf and others, 1973). Many activities of man generate contaminants, which ultimately move down through the soils and rocks into underground drinking-water sources. From an overall national viewpoint, ground-water contamination results from seepage into aquifers of contaminated ground water from millions of individual local point sources such as injection wells and industrial lagoons or basins, and a much smaller number of non-point or regional sources such as return flows or irrigation water, intrusion of salty ground water in coastal areas, and urban runoff.

There are two major differences between ground-water and surface-water contamination. First, contaminated surface water can move at velocities measured in terms of several feet per second or more, whereas contaminated ground water moves at velocities that range from only several feet per day to less than a fraction of a foot per day. Consequently, surface-water contamination may be of short duration, if the source of the contamination is eliminated or brought under control, but ground-water contamination may persist for decades or longer because of the generally slow rate of movement of contaminated ground water. Moreover, contaminated surface water is generally easily recognizable, either by visible effects, such as changes in color and the killing off of fish and benthic organisms, or it can be readily detected by analytical techniques, whereas ground water, which is hidden from view and is difficult to study, may have undergone contamination for many years before the problem is detected, perhaps at a down-gradient well where the contamination shows up in a pumped water sample.

In recent years, with the growing emphasis by State and Federal agencies on control of surface-water contamination, there has been a tendency on the part of producers of wastes to resort more to underground injection which, as a consequence, has increased the amount of ground-water contamination. The sources and causes of this contamination include not only the underground injection practices listed previously, but a variety of other activities or facilities of man such as the following:

(a) disposal, storage, or treatment of hazardous, toxic, or otherwise objectionable fluids into pits, basins, or lagoons at industrial or municipal sites;

(b) disposal of partly treated sewage from industrial and municipal septic systems;

(c) seepage of leachates from municipal and industrial landfills;

(d) leaks in underground facilities such as oil pipelines, sanitary sewers, and buried gasoline tanks;

(e) generation of acidic leachates as a result of mining activities;

(f) migration of poor quality ground water into freshwater aquifers as a result of overpumping of wells;

(g) interchange of ground water from one water-bearing zone to another through boreholes and wells;

(h) wastepiles and stockpiles, which are leached by precipitation;

(i) animal feed lots and dairies that produce large quantities of wastes which commonly percolate into the ground;

(j) fertilizers applied to agricultural areas;

(k) pesticides used in gardens and rural areas;

(l) accidental spills of hazardous or toxic substances;

(m) applications of salt on highways to melt ice; and

(n) land spreading of sewage effluent and sludge for fertilizer use.

B. Summary of Prior Federal Legislation.

1. Drinking Water Standards, 1914-62. The earliest Federal legislative concern with protecting public health through control of the quality of water supplies was expressed in the Interstate Quarantine Act of 1893 and the Interstate Quarantine Regulations of 1894 in which Congress authorized the U. S. Public Health Service to make and enforce regulations to prevent the spread of communicable diseases from foreign countries into States or from State to State. A problem of special concern in the late 1800's and early 1900's was the incidence of typhoid in the major cities of the United States, which came to be recognized as a largely waterborne disease mainly attributable to contaminated streams and some contaminated aquifers, which were sources of water for public supplies. Congress enacted the first laws dealing with pollution of navigable streams and lakes in 1912. By 1914, the first official drinking water standard, to protect the traveling public, was adopted by the U. S. Public Health Service. The standard was based on bacterial content and was applicable to any water system that supplied an interstate common carrier. In 1925, the standards were revised to include certain chemical and physical characteristics of the water. The standards were revised again in 1942 to improve requirements for bacterial examination and to establish maximum permissible limits for a variety of chemical constituents in the water. The standards were revised slightly in 1946, mainly to make the standards

generally acceptable to all public-water supplies in the United States.

During the period from about 1915 to 1948, water pollution control was largely in the hands of State agencies, mainly State Health Departments, with research and technical advisory assistance being provided to the States by the Public Health Service. In 1962, the Drinking Water Standards were updated to include requirements for qualified personnel, maximum limiting concentrations for additional heavy metals, certain organic chemicals, fluoride, and radioactivity. The standards were again mandatory only for water systems supplying interstate common carriers and others subject to Federal quarantine regulations. However, the American Water Works Association (U. S. Public Health Service, 1962), adopted a resolution endorsing the Drinking Water Standards as recommended minimum standards for all public water supplies.

McDermott (1973) points out that the Public Health Service Advisory Committee on Drinking Water Standards, which was appraising the need for pesticide standards, was reminded in 1967 that the legislative basis for the Drinking Water Standards was control of communicable diseases. Therefore, the Public Health Service had no legal authority to establish drinking-water standards based only on chemical content. Clearly, there was a need for further legislation to assure safe drinking water supplies from public water-supply systems.

2. Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500).

Further progress in water pollution control was made through passage of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). This Act replaced the Federal Water Pollution Control Acts of 1948 and 1956 and amendments in 1965, 1966, and 1970 which were intended to control and abate pollution of streams and lakes by promulgation of State water-quality standards and encouragement of construction of sewage and waste-treatment facilities.

The 1972 Act, which is the first major piece of Federal legislation that deals directly with ground-water quality protection, specifies that "the Administrator shall, in cooperation with Federal, State, and local agencies and industries, develop comprehensive programs for preventing, reducing, or eliminating pollution of navigable waters and ground water and improving the sanitary conditions of surface and underground water."

The Act requires establishment of ground-water quality monitoring programs. The Administrator is also required to issue guidelines for disposal of pollutants in wells or in subsurface excavations. P.L. 92-500 specifies in addition that States should operate permit programs to "control the disposal of pollutants into wells." Under the National Pollutant Discharge Elimination System (Section 402), EPA is required to review

State applications to operate such permit systems and may disapprove such applications if the requirements of the Act are not met. However, while it appears that EPA may be authorized to prescribe its own program to control the disposal of pollutants into wells if it does not approve a State's program, this authorization has not been established by any judicial decision.

EPA has interpreted the NPDES section of P.L. 92-500 to mean that an operator of a disposal well must have an NPDES permit under the following conditions:

(1) If there is also a surface discharge on the property that requires an NPDES permit; in this case, both discharges will be under one permit;

(2) If there was a surface discharge in the past, which has been replaced by the disposal well; and

(3) If the injector never had a surface discharge, and all wastes are being injected, then no NPDES permit is required. In such a case, if the injector initiates a surface discharge in the future that does require a permit, then the injection well will also have to be permitted at that time.

P.L. 92-500 states that no permit or authorization is required for "...water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if such State determines that such injection or disposal will not result in the degradation of ground- or surface-water resources."

The restrictive definition of a pollutant in P.L. 92-500 (includes dredged soil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, biological and radioactive materials, heat, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste) tends to weaken the Federal government's ability to adequately protect underground drinking-water sources.

3. Administrator's Decision Statement No. 5. In April 1974, the Administrator of EPA issued a policy statement on subsurface emplacement of fluids. This statement was partly an outgrowth of a policy statement by the Federal Water Quality Administration in October 1970, and partly an outgrowth of Section 402 in P.L. 92-500 dealing with the disposal of contaminants into wells. It was designed to establish EPA's concern with the techniques used in fluid storage and disposal, and to express EPA's position of approving such fluid emplacement only where it is demonstrated to be the most environmentally acceptable available method of handling fluid storage or disposal. The policy sets forth EPA's position on deep-well disposal and provides guidance to Federal agencies, the States, and other interested parties.

Administrator's Decision Statement No. 5 (ADS-5) is designed to (a) protect the subsurface from contamination or other environmental hazards attributable to improper injection or poorly sited injection wells, (b) insure that engineering and geological safeguards adequate to protect the integrity of the subsurface environment are adhered to in the preliminary investigations, design, construction, operation, monitoring, and abandonment phases of injection well projects, and (c) encourage development of alternative means of disposal which afford greater environmental protection.

To insure accomplishment of the goals established by the subsurface protection policy, the statement specifies that (a) EPA will oppose emplacement of materials by subsurface injection without strict control and without a clear demonstration that such emplacement will not interfere with present or potential use of the subsurface environment, contaminate ground-water resources, or otherwise damage the environment, (b) all proposals for subsurface injection should be critically evaluated to determine that the various provisions, measures, and technical guidelines in the statement have been followed, (c) where subsurface injection is practiced for waste disposal, it is to be recognized as only a temporary means of disposal until new technology becomes available, and (d) where subsurface injection is practiced for underground storage or for recycling of natural fluids, such practice will cease or will be modified when a hazard to natural resources or the environment appears imminent.

Accompanying the policy statement are recommended data requirements for environmental evaluation of subsurface emplacement of fluids by well injection. These data relate to the kinds of information needed to evaluate prospective injection well systems and to protect the environment. They list certain types of information that should be provided by the injector, including maps, geological cross sections, descriptions of the hydrological environment of the area in which the injection is taking place, the chemical, physical, and biological properties of the fluids to be injected, the nature and composition of the underground geologic formations, the chemistry of the natural waters, the pressure increases expected as a result of the injection, and engineering data on the wells, their method of construction, and the control devices installed to insure against contamination of water resources.

Much of the philosophy of ADS-5 has been incorporated in the proposed regulations for UIC programs, and it is intended that the States will utilize some of the data requirement provisions of the Statement in connection with certain types of underground injection facilities to be specified in the State programs.

4. Safe Drinking Water Act (P.L. 93-523). Because prior Federal legislation, except for scattered statements in P.L. 92-500, did not deal directly or in detail with the protection of underground drinking-water sources from contamination by uncontrolled subsurface injection of fluids, Congress recognized the need for further legislation in this area. The principal objectives of the new legislation (P.L. 93-523) are stated concisely in the Committee on Interstate and Foreign Commerce Report (93-1185, July 1974, p. 1) as follows: ". . . to assure that water-supply systems serving the public meet minimum national standards for protection of public health. At present, the Environmental Protection Agency is authorized to prescribe Federal drinking-water standards only for water supplies used by interstate carriers. Furthermore, these standards may only be enforced with respect to contaminants capable of causing communicable disease. In contrast, this bill would: (1) authorize the Environmental Protection Agency to establish Federal standards for protection from all harmful contaminants, which standards would be applicable to all public-water systems, and (2) establish a joint Federal-State system for assuring compliance with these standards and for protecting underground sources of drinking water."

a. Legislative Background. During the 92nd Congress, the Subcommittee on Public Health and Environment of the Committee on Interstate and Foreign Commerce, House of Representatives, held two sets of hearings on bills relating to protection of public health through assurance of safe community drinking-water supplies. On May 24, 25, and 26, 1971, the Subcommittee held hearings on H.R. 1093, H.R. 5454, and H.R. 437. On May 10, 1972, a clean bill, H.R. 14899 was introduced. Supplemental hearings on that bill were conducted on June 7 and 8, 1972. None of the aforementioned bills were ordered reported by the full committee during the 92nd Congress.

During the 93rd Congress, several bills dealing with the protection of community water supplies were under consideration. On January 3, 1973, H.R. 1059--the "Safe Drinking Water Act"--was introduced. The Administration's bill, H.R. 5368, was introduced on March 7, 1973. An identical bill, H.R. 5395, was introduced on March 8, 1973.

Hearings on these bills were held before the Subcommittee on March 8 and 9, 1973. Subsequently, the Subcommittee ordered reported as clean bills, H.R. 9726 and H.R. 10955. Each of these represented modified versions of H.R. 1059. Finally, on February 21, 1974, a new clean bill, H.R. 13002, was introduced and was ordered reported by the Subcommittee to the Committee on Interstate and Foreign Commerce. On June 20, 1974, the Committee by voice vote ordered reported H.R. 13002, as amended. Comparable legislation (S.433) was passed by voice vote of the Senate on June 22, 1974. P.L. 93-523 was enacted by Congress, December 16, 1974.

b. Basic Provisions Pertaining to Underground Injection. Section 1421 (a)(1) of the Safe Drinking Water Act provides that the Administrator of EPA "shall publish proposed regulations for State underground injection control programs within 180 days after enactment of this title. Within 180 days after publication of such proposed regulations, he shall promulgate such regulations with such modifications as he deems appropriate. Any regulation under this subsection may be amended from time to time."

Section 1421(b)(1) provides that the "regulations for State UIC programs shall contain minimum requirements for effective programs to prevent underground injection which endangers drinking-water sources. Such regulations shall require that a State program, in order to be approved under Section 1422, shall:

(a) prohibit, effective three years after the date of the enactment of this title, any underground injection in such State which is not authorized by a permit issued by the State (except that the regulations may permit a State to authorize underground injection by rule),

(b) require (1) in the case of a program which provides for authorization of underground injection by permit, that the applicant for the permit to inject must satisfy the State that the underground injection will not endanger drinking-water sources and (2) in the case of a program which provides for such an authorization by rule, that no rule may be promulgated which authorizes any underground injection which endangers drinking-water sources,

(c) include inspection, monitoring, recordkeeping, and reporting requirements, and

(d) apply (1) as prescribed by Section 1447(b) to underground injections by Federal agencies, and (2) to underground injections by any other person whether or not occurring on property owned or leased by the United States."

Section 1421(b)(2) provides that "regulations of the Administrator under this section for State UIC programs may not prescribe requirements which interfere with or impede:

(a) the underground injection of brine or other fluids which are brought to the surface in connection with oil or natural gas production, or

(b) any underground injection for the secondary or tertiary recovery of oil or natural gas, unless such requirements are essential to assure that underground sources of drinking water will not be endangered by such injection."

c. State Permit Programs. The intent of the Act is to establish a Federal-State system of regulation to assure that drinking-water sources are not rendered unfit for use as a result of underground injection of contaminants. The guidelines for the State regulatory programs are to be promulgated by the Administrator of EPA within 360 days after passage of the Act. Prior to that time, the proposed regulations will have been submitted to the States for review and will have been presented at public hearings so that EPA can make changes or modifications before the deadline for the actual promulgation of the regulations.

In summary, the Administrator's guidelines for State UIC programs require States, as a minimum, to (a) prohibit unauthorized underground injection effective three years after enactment of the bill, (b) require the applicant for an underground injection permit to bear the burden of proving to the State that the injection will not endanger drinking-water sources, (c) refrain from adopting regulations which, if applied, would authorize injection that endangers underground drinking-water sources, (d) adopt inspection, monitoring, recordkeeping, and reporting requirements for the purpose of controlling injection, and (e) apply their injection control programs to Federal agencies as well as to other persons, whether or not the injection is occurring on Federally-owned or leased property.

d. Temporary Permits. The Act recognizes that some States may not be able to process all permit applications for new and existing underground injection wells within the three-year deadline established by the Act. Consequently, upon application by the Governor of a State, the Administrator may, at his discretion, allow the State to issue temporary permits for one additional year. The Administrator may allow the issuance of such temporary permits only under the following conditions:

(a) the State must bear the burden of proving that it cannot process all permit applications in time, (b) the temporary permit may be issued only for unprocessed permit applications for underground injection facilities in operation at the time of EPA's approval of the State program, (c) the temporary permit must provide that generally available techniques be utilized to minimize the likelihood of contaminating drinking-water sources, and (d) the Administrator must determine that the issuance of temporary permits is warranted, notwithstanding the adverse environmental or public-health effects.

e. Interim Permits for Sole-Source Aquifers. Section 1424(a) of the Act deals with problems that may have to be addressed during the three-year period before State underground injection control programs become effective under Section 1421. Such a problem could arise, for example, in places where there is only a single aquifer that is the sole, or principal, drinking-water source, and where contamination of that aquifer would pose a significant hazard to public health.

In such a case, the Administrator is authorized, upon petition of any person, to designate such an area as one in which no new underground injection wells may be operated unless he has issued a permit for such operation. The Administrator's authority to make such an interim designation terminates on the date on which the applicable UIC program for that area becomes effective.

5. House Report - No. 93-1185, July 1974. One of the most important definitions in the Safe Drinking Water Act is that for "underground injection." It was the intent of Congress, as interpreted from the committee hearings and reports at the time the provisions of the Act were under discussion, that underground injection was limited to deliberate subsurface emplacement by wells, either permanently or temporarily, of any contaminant that flows or moves, whether the contaminant is in a semi-solid, liquid, sludge, or any other form or state. The definition also was intended to apply to the injection of brine or other fluids for secondary recovery in oil and gas fields, solution extraction of minerals, artificial recharging operations, injection of fluids to control salt-water intrusion, and similar practices listed in Table 2.

Congress included in the Act a specific amendment expressing its desire not to authorize needless interference with oil or gas production. This amendment prohibits State UIC programs from prescribing requirements that would interfere with production of oil and natural gas or disposal of by-products associated with such production, except that such requirements are authorized if they are essential to insure that underground sources of drinking water will not be endangered by such activities.

C. Conditions Upon Which the Regulations are Based.

1. Status of Well Injection Practices. No statistical inventory of all of the types of underground injection included in the

Table 2. - ESTIMATED NUMBER OF UNDERGROUND INJECTION FACILITIES IN THE UNITED STATES

Category	Number
I. Waste Disposal and Engineering Wells	
(1) Conventional industrial wells.	360
(2) Conventional municipal wells	30
(3) Municipal shallow wells.	1,000
(4) Industrial shallow wells	1,000
(5) Barrier wells.	100
(6) Recharge wells for aquifer augmentation.	200
(7) Solution mining wells.	500
(8) Gas storage wells.	14,500
(9) Geothermal wells	10
II. Injection Wells Related to Oil and Gas Production	
(1) Brine disposal wells	10,000
(2) Secondary recovery wells	60,000
III. Other Underground Injection	
(1) Drainage wells (agricultural and urban runoff) .	50,000

UIC regulations has ever been made, although there are some scattered data relating to certain types of underground injection. Table 2 is a list showing the estimated numbers of such facilities, based partly on factual information and partly on the judgment of professionals working in the field. Each of the injection practices for which controls are mandatory is discussed below:

a. Waste Disposal and Engineering Wells.

(1) Conventional municipal and industrial disposal wells injecting wastes and effluent into deep saline-water aquifers generally range in depth from a few hundred to several thousand feet. The typical construction of such industrial and municipal wells and a hypothetical body of contaminated fluids in the injection zone are shown in Figure 1. As of mid-1975, 284 industrial and municipal waste injection wells were in operative condition in 25 States (after Reeder and others, 1975). Only 20 of the wells inventoried were municipal, and these were in Florida, Hawaii, Louisiana, and Texas. Also as of mid-1975, there were about 360 conventional industrial wells and 30 conventional municipal wells which have been constructed (including operational and abandoned wells) or are in the planning stage.

Figure 2 shows the general distribution of operating industrial and municipal disposal wells in 1975, and Figure 3 shows the geologic suitability of the receiving formations for

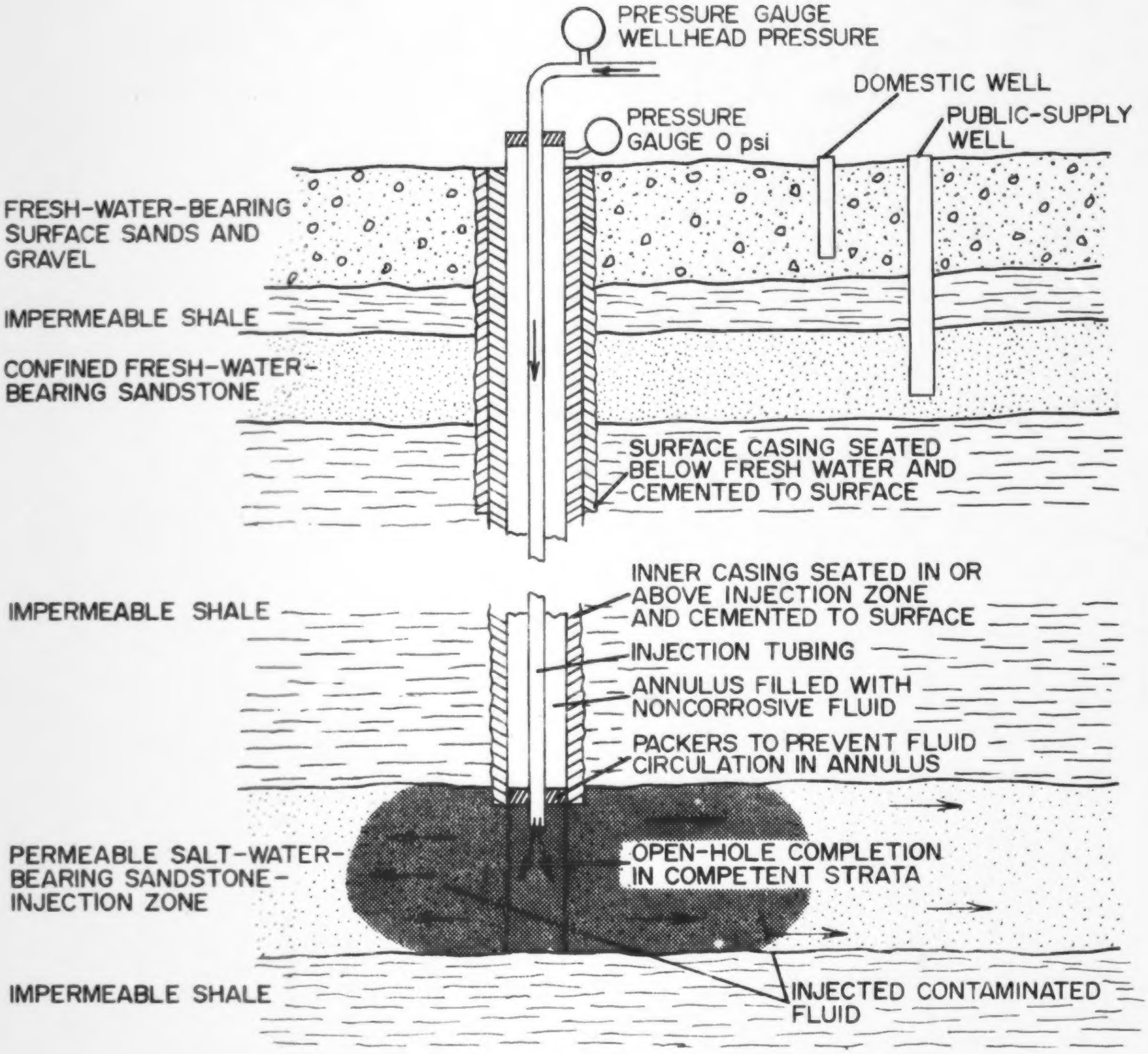

PRESSURE GAUGE
WELLHEAD PRESSURE
DOMESTIC WELL
PRESSURE GAUGE 0 psi
PUBLIC-SUPPLY WELL
FRESH-WATER-BEARING SURFACE SANDS AND GRAVEL
IMPERMEABLE SHALE
CONFINED FRESH-WATER-BEARING SANDSTONE
SURFACE CASING SEATED BELOW FRESH WATER AND CEMENTED TO SURFACE
INNER CASING SEATED IN OR ABOVE INJECTION ZONE AND CEMENTED TO SURFACE
IMPERMEABLE SHALE
INJECTION TUBING
ANNULUS FILLED WITH NONCORROSIVE FLUID
PACKERS TO PREVENT FLUID CIRCULATION IN ANNULUS
PERMEABLE SALT-WATER-BEARING SANDSTONE-INJECTION ZONE
OPEN-HOLE COMPLETION IN COMPETENT STRATA
IMPERMEABLE SHALE
INJECTED CONTAMINATED FLUID

Figure 1. Diagram of a Conventional Industrial Injection Well Completed in Sandstone (modified in part from Warner, 1965).

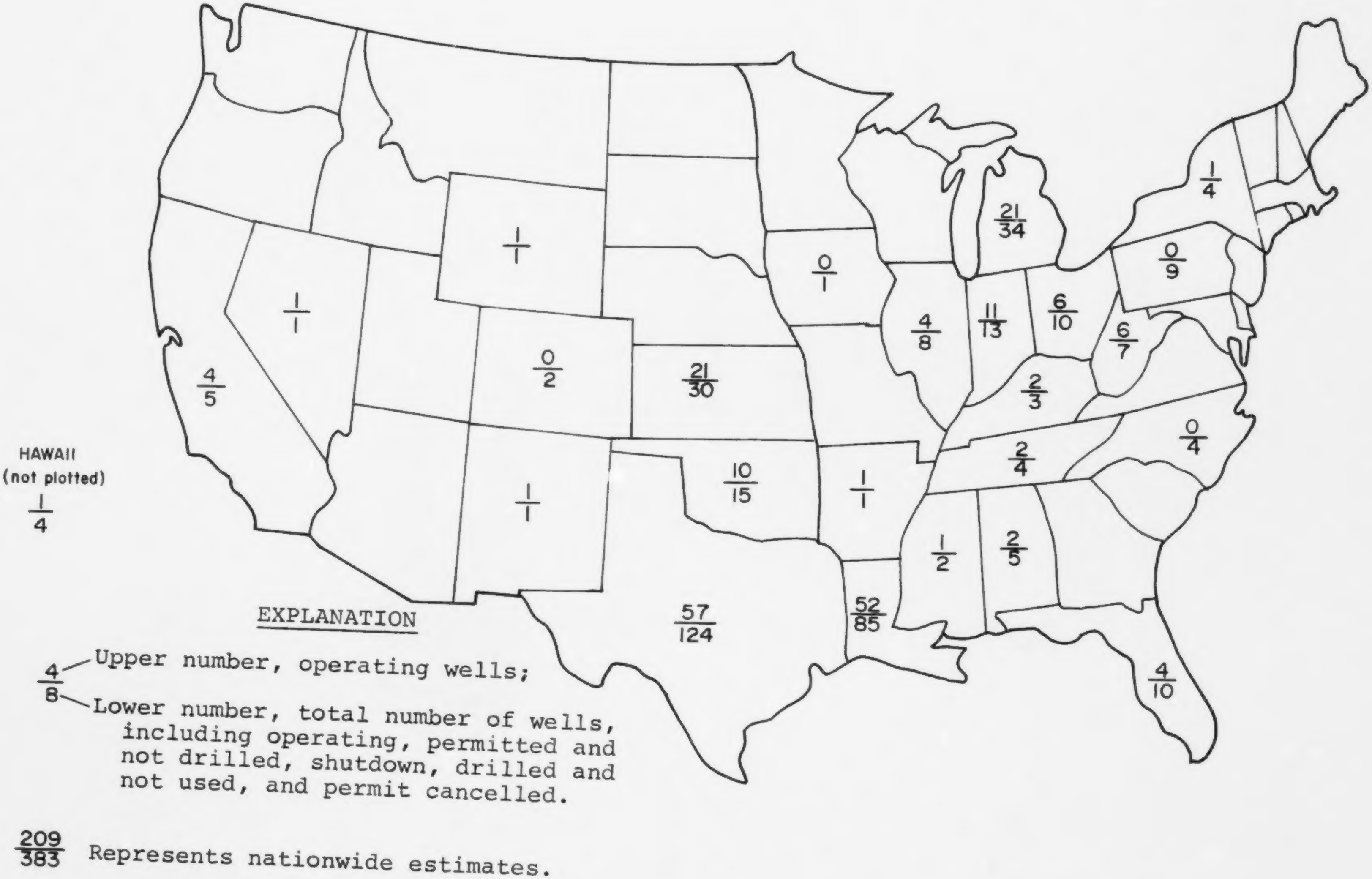
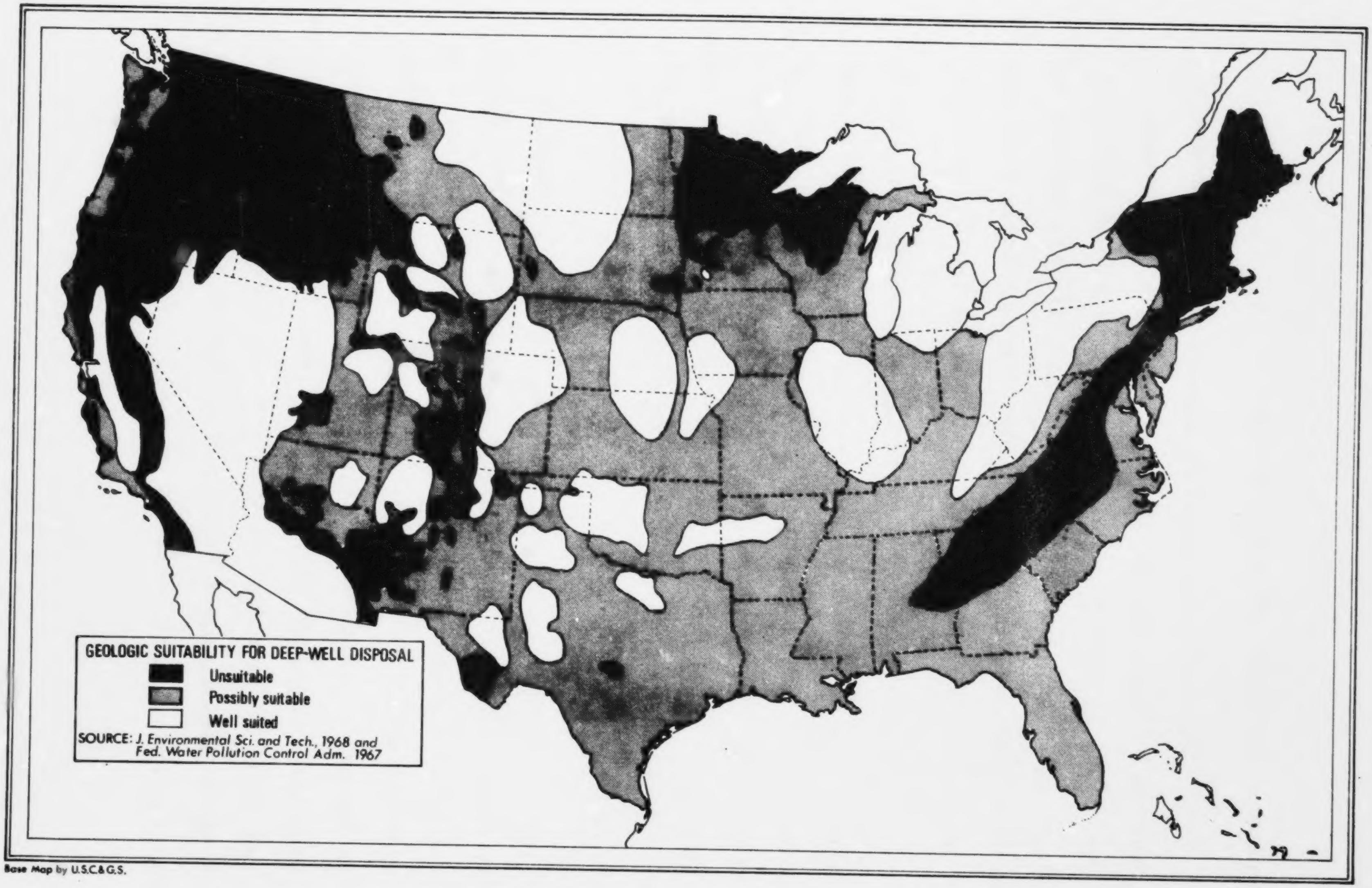

HAWAII
(not plotted)
1/4
4/5
1/1
1/1
0/2
1/1
21/30
10/15
57/124
0/1
1/1
52/85
4/8
11/13
21/34
6/10
2/3
2/4
1/2
2/5
6/7
0/9
1/4
0/4
4/10
EXPLANATION
4/8
Upper number, operating wells;
Lower number, total number of wells, including operating, permitted and not drilled, shutdown, drilled and not used, and permit cancelled.
209/383 Represents nationwide estimates.

Figure 2. Distribution and Status of Conventional Industrial and Municipal Wells in the United States (after Reeder and others, 1975).


GEOLOGIC SUITABILITY FOR DEEP-WELL DISPOSAL
Unsuitable
Possibly suitable
Well suited

SOURCE: J. Environmental Sci. and Tech., 1968 and Fed. Water Pollution Control Adm. 1967

Base Map by U.S.C.&G.S.

Figure 3. Geologic Suitability of Formations for Conventional Injection of Waste Fluids (after Geraghty and others, Water Atlas, 1973).

conventional injection of waste fluids.

The historical trend in construction of industrial and municipal disposal wells is shown in Figure 4. Between 1967 and 1973, an average of about 28 industrial and municipal injection wells per year were constructed. If this average rate is extrapolated into the future, about 614 such wells will have been constructed by 1985 and 1,034 such wells by the year 2000.

Warner and others (1975) estimated that the average continuous injection rate in 1973 was 100 gpm per well and the injected volume of waste in that year was about 24 mgd. If, as in 1973, about 60 percent of the constructed wells were to be in operation in 1985 and 2000, and if the average injection rate were to remain at 100 gpm, the estimated daily injected volumes would be 53 mgd and 89 mgd, respectively, in those years.

In addition to gathering information on existing wells during the study made by Warner and Orcutt (1973), Warner made a brief assessment of the probable environmental impact of each of the wells that has been constructed and operated. Tangible results of waste water injection that can be predicted to occur in every case are: (1) modification of the ground-water system; and (2) introduction into the subsurface of fluids with a chemical composition different from that of the natural fluids. Tangible impacts that could occur in individual cases are:

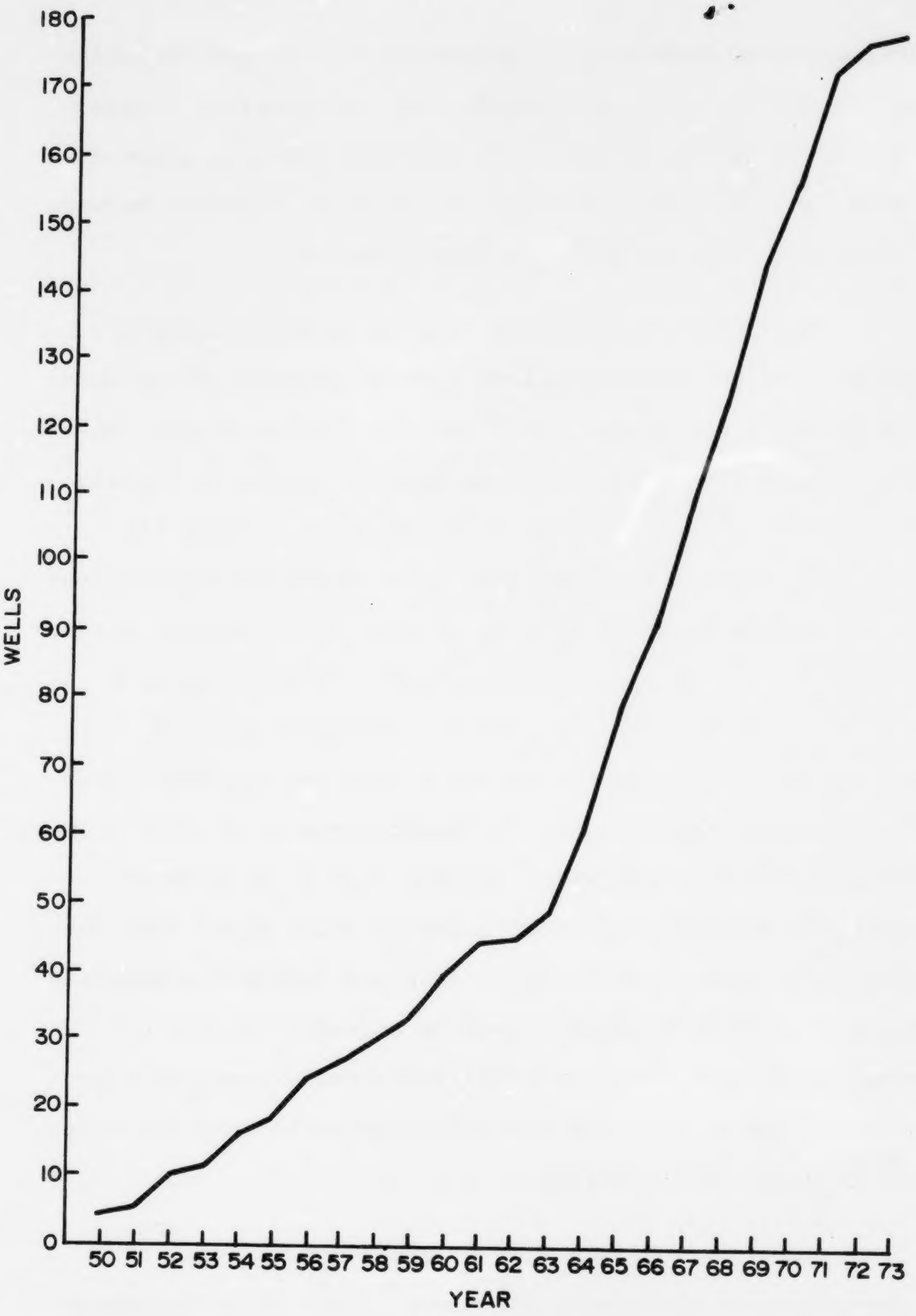


Figure 4. Growth of Operating Injection Wells in U. S. (Environmental Protection Agency, 1974).

(1) degradation of high-quality ground water; (2) contamination of other resources, e.g., petroleum, coal, or chemical brines; (3) stimulation of earthquakes; (4) chemical reaction between waste water and natural water; and (5) chemical reaction between waste water and rocks in the injection interval.

The impact of greatest concern to most regulatory agencies is that of direct contamination of potable ground water by the injected waste water. This can occur where a well, designed to inject into a saline-water aquifer, fails to operate properly because of: (1) escape of waste water through the well bore into a fresh-water aquifer as a result of insufficient casing, corrosion, or other failure of the injection-well casing; (2) vertical escape of injected waste water outside the well casing from the injection zone into a fresh-water aquifer; (3) vertical escape of injected waste water from the injection zone through confining beds that are inadequate because of high primary permeability, solution channels, joints, faults, or induced fractures; (4) vertical escape of injected waste water from the injection zone through nearby wells that are improperly cemented or plugged or that have insufficient or corroded casing; and (5) lateral migration of waste water, originally injected into a saline-water zone, into a fresh ground-water zone at the same depth as the injection interval.

Indirect contamination of fresh ground water can occur when injected waste water displaces salty formation water vertically, causing it to flow upward into a fresh-water aquifer. The vertical flow of the saline water could be through paths of natural or induced permeability in confining beds or through inadequately cased wells drilled through the fresh water-salt water interface.

In most existing wells, the potential for contamination of fresh ground water is small because of the construction of these wells and because of the large horizontal and vertical distances between the injection zones and fresh-water aquifers. The belief that the potential for this type of contamination is small is supported by the few instances of direct contamination that have been documented. For example, in the hearings on the Safe Drinking Water Act, only three cases of ground-water contamination from conventional industrial injection wells were cited. No instance of contamination of other subsurface resources by injected industrial waste water has been reported to date. The fact that little evidence of degradation of potable ground water and other resources by this type of injected waste water has been found should not be cause for relaxation of vigilance in regulating and operating such disposal wells.

(2) Industries and municipalities are injecting fluids of all kinds into shallow fresh-water aquifers through drilled, bored, or driven cased wells.

Modification of the existing quality of the native ground water caused by subsurface disposal of fluids through a well depends on a variety of factors, including the composition of the native water, the amount and composition of the injected fluid, the rate at which the injection takes place, the permeability of the aquifer, the type of construction and life expectancy of the well, and the kinds of biological and chemical degradation that may take place within the well and the aquifer. In general, for economic reasons, wells used for disposal of contaminated liquids in fresh-water aquifers tap the shallowest available aquifer. Commonly, this is a water-table aquifer. Some wells, however, are terminated at greater depths in confined fresh-water aquifers.

Initially, injection of contaminated liquids through wells into fresh-water aquifers causes degradation of the chemical and bacteriological quality of the ground water in the immediate vicinity of the injection facilities. Eventually, the degradation spreads over a wider region and may ultimately extend into surface waters that are hydraulically connected with the receiving aquifer. If the cones of depression in the water levels of nearby operating water-supply wells are large enough to include the injection site, or if the wells are down-gradient along natural flow lines from the injection site, contamination of these wells may take place. Another potential effect in some hydrogeologic environments is movement of the contaminated water from the injection zone into overlying or underlying fresh-water aquifers.

Fuhriman and Barton (1971), referring to ground-water pollution in the southwestern United States, stated that "occasionally, industries or others have used shallow injection wells to dispose of liquid wastes," and cited as an example electronic industries that disposed of metal-plating wastes by means of injection wells in Arizona. In the Snake River Plain of Idaho, wells are also used to dispose of industrial and sewage wastes into shallow aquifers (Abegglen and others, 1970). An estimated 1,000 industrial wells injecting fluids into shallow fresh-water aquifers exist today (Table 2).

Industrial wastes injected through wells range widely in composition and toxicity, depending on the particular industrial operation and the degree of treatment of the wastes before disposal. Plating wastes, pickling wastes, and acids are some of the more toxic fluids disposed of through wells into freshwater aquifers.

Partly treated or untreated sewage is disposed of through municipal shallow wells in parts of the country. It is estimated that about 1,000 such wells are in operation.

(3) Subsidence control wells are used to repressure aquifers to counteract the subsidence induced by the previous removal of oil, gas, or water. Poland (1972) describes existing operations of this type, the largest of which, in this country, is in the vicinity of Wilmington oil field in the Long Beach,

California, area. By 1969, 1.1 million barrels of water per day were being injected in the Wilmington oil field area. It is estimated that 500 wells of this type may exist.

Ground-water contamination from subsidence control wells could occur in the same ways described previously in the case of industrial disposal wells. This would only be a significant hazard where sea water, saline ground water, or other poor-quality water is being injected.

(4) Barrier or sea-water intrusion control wells are used in coastal areas to provide a hydraulic barrier to the movement of sea water into heavily pumped fresh-water-bearing aquifers. Perhaps 100 such wells exist, almost entirely in California. A sketch of such a well is given in Figure 5 . Such wells are for a beneficial purpose but may be injecting water of lower quality than the native ground water and, therefore, their construction and operation need to be controlled.

(5) Artificial recharge wells used to inject water underground for augmentation of water supplies in aquifers where the ground water has been depleted by heavy pumping can become conduits for movement of contaminated ground water, if not carefully controlled. A partial, probably conservative inventory of such injection devices in 1968 (International Association of Scientific Hydrology, 1970), gave information on 184 recharge wells and 56 basins. The contamination potential of such

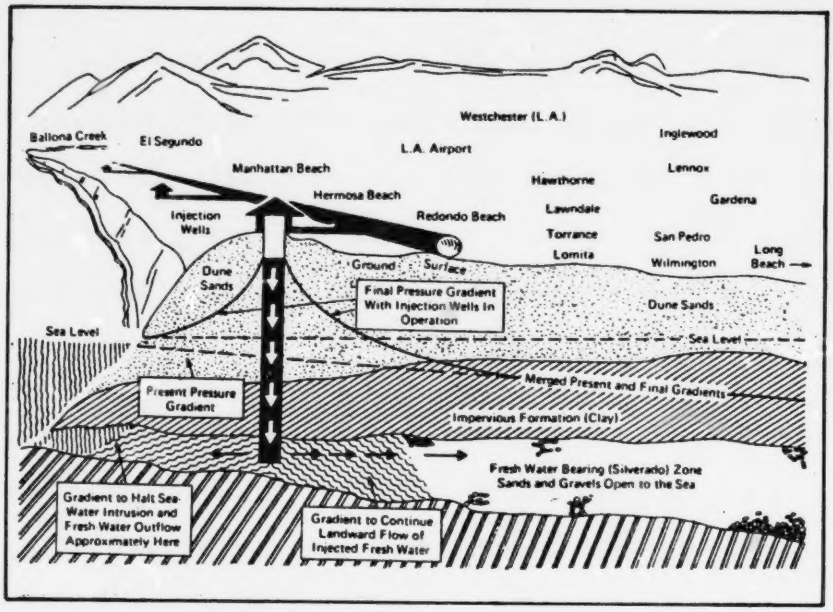

Westchester (L.A.)
Ballona Creek
El Segundo
L.A. Airport
Inglewood
Manhattan Beach
Lennox
Hawthorne
Hermosa Beach
Gardena
Injection Wells
Redondo Beach
Lawndale
Torrance
San Pedro
Lomita
Wilmington
Long Beach
Ground Surface
Dune Sands
Final Pressure Gradient With Injection Wells In Operation
Dune Sands
Sea Level
Sea Level
Merged Present and Final Gradients
Present Pressure Gradient
Impervious Formation (Clay)
Fresh Water Bearing (Silverado) Zone Sands and Gravels Open to the Sea
Gradient to Halt Sea-Water Intrusion and Fresh Water Outflow Approximately Here
Gradient to Continue Landward Flow of Injected Fresh Water

Figure 5. Sketch of West Coast Basin Barrier, Los Angeles, California (after West Coast Basin Water Association).

underground injection practices is similar to that described previously for barrier and industrial wells and depends largely on the quality of the injected water and careful control of the injection procedures. For example, augmentation of an aquifer by underground injection of river or lake water or water from another aquifer can cause chemical or bacterial contamination of the receiving aquifer. Similarly, recharge of deep aquifers through connector wells by gravity flow from overlying contaminated shallow aquifers may introduce contaminants into the receiving aquifers.

(6) Solution-mining wells have been used for many years to extract sulfur, salt, and other minerals from the subsurface by injection of water and extraction of the minerals in solution. Figure 6 depicts a well for solution mining of sulfur. In many cases, the residual brine from such operations is disposed of through injection wells. A similar type of operation, widely practiced in areas where salt deposits exist, is the construction of solution caverns for storage of liquid petroleum gas. In this procedure, water is injected into the salt beds and a cavern is developed as the salt is dissolved and the brine is pumped out. The extracted brine is then disposed of by injection into a suitable aquifer. A relatively new but growing practice is the in-situ mining of metals, particularly copper and uranium, by injection of acid through wells into an ore body or a tailings pile. This is followed by extraction of

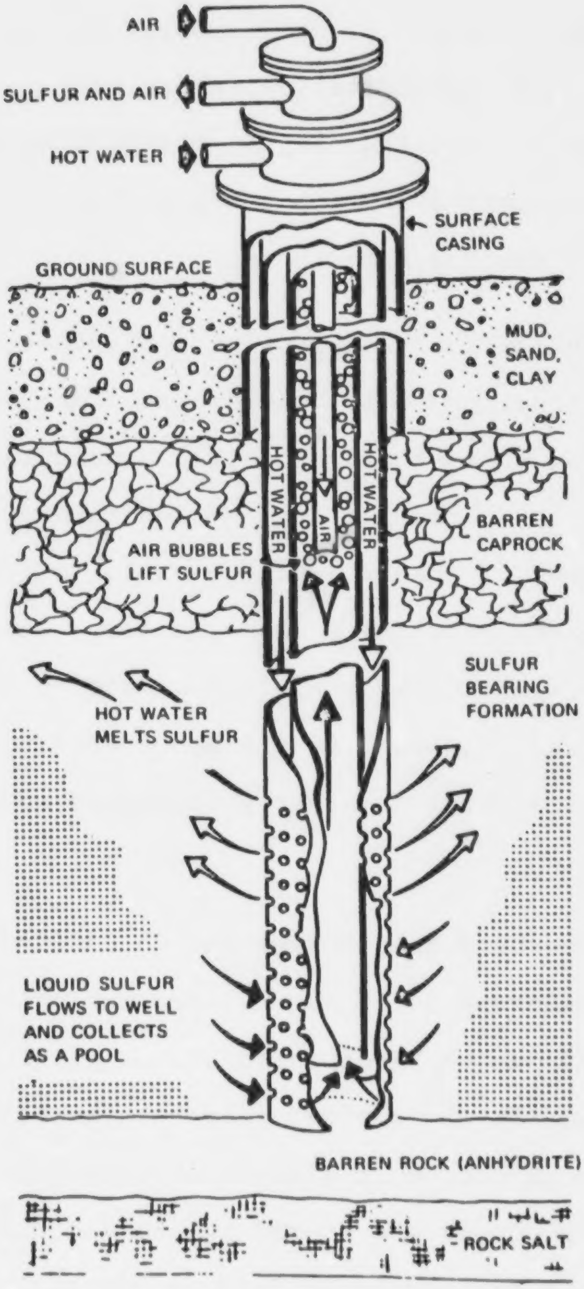

AIR
SULFUR AND AIR
HOT WATER
SURFACE CASING
GROUND SURFACE
MUD, SAND, CLAY
HOT WATER
AIR
HOT WATER
BARREN CAPROCK
AIR BUBBLES LIFT SULFUR
SULFUR BEARING FORMATION
HOT WATER MELTS SULFUR
LIQUID SULFUR FLOWS TO WELL AND COLLECTS AS A POOL
BARREN ROCK (ANHYDRITE)
ROCK SALT

Figure 6. Operation of a Sulfur Well During Solution Mining of Sulfur by the Frasch Process (Donner and Wornat, 1973).

the solution containing the metal through pumping wells or as seepage. It is estimated that there are as many as 500 solution-mining wells in the country, mostly in New York, Ohio, Michigan, Texas, and Louisiana, where salt and sulfur mining are practiced. Metal mining by leaching is primarily practiced in the western States, but the number of wells presently used for that purpose is small.

The potential for ground-water contamination from solution mining of sulfur, salt, and other water-soluble minerals is similar to that described for industrial and municipal disposal wells. Solution mining of metallic minerals presents a different problem, in that the mining will, in most cases, be in geologic strata containing usable water. Therefore, the mining itself may need to be carefully managed to avoid ground-water contamination. Disposal of the spent acid solutions by injection would be similar to other underground industrial injection practices.

(7) Underground gas storage may be defined as storage in rock of synthetic gas or of natural gas not native to the location. Storage can be in depleted oil or gas reservoirs, in ground-water aquifers, in mined caverns, or in dissolved salt caverns. Gas may be stored in gaseous or liquid form. The largest quantities of gas are stored in the gaseous form in depleted oil or gas reservoirs or in deep artesian aquifers. In 1971, there were 333 underground gas storage fields in 26 States.

About 60 percent of the storage capacity was located in Illinois, Pennsylvania, Michigan, Ohio, and West Virginia. The number of wells per field ranges from less than 10 to more than 100, depending on the size of the structure in which the gas is being stored (American Gas Association, 1971). As of 1971, about 14,500 gas storage wells existed (op. cit.). Probably several hundred such wells are constructed each year.

Underground gas storage fields present a potential for contamination of usable ground water by upward leakage of gas through the cap rock, through abandoned improperly plugged wells, or through inadequately constructed gas injection or withdrawal wells. Gas could also escape from an overfilled field and migrate laterally in the storage aquifer, which in some cases contains usable water. A case history of a leaky storage field in Illinois was documented by Hallden (1961). In that instance, it was not possible to conclusively determine whether the leakage was from faulty well cementing, lack of an adequate cap rock, faulting of the cap rock, or unplugged abandoned wells. Some leakage from storage fields is common; but, since the gas is a valuable commodity, operating companies have a strong interest in minimizing such losses. In addition, storage fields are subject to State or Federal licensing and regulation, the engineering characteristics of a field must be carefully determined prior to licensing, and the fields must be monitored during operation.

(8) Geothermal wells are potential sources of ground-water contamination. In the United States, about 1.8 million

acres are designated as known geothermal resource areas and an additional 95.7 million acres have prospective value (U. S. Department of the Interior, 1971). Of the known areas, 90 percent lie in the thirteen western States and Alaska. Geothermal reservoirs may contain either dry steam or hot brines, with the latter predominating. Both condensed steam and cooled brines commonly are reinjected through wells into the geothermal structure (U. S. Department of the Interior, 1971). The total number of geothermal injection wells is unknown but is estimated to be not less than 10.

The United States Bureau of Reclamation and others have proposed major developments of geothermal energy from the hot brine reservoirs underlying the Imperial Valley in California. The Bureau of Reclamation concept contemplates production of 2.5 million acre-feet of fresh water per year from 3 to 4 million acre-feet of brines. The desalted water would be replaced with water from the Pacific Ocean, the Salton Sea, or other sources; mixed with residual brines, the replacement water would be injected through approximately 100 wells on the periphery of the geothermal field, to maintain reservoir pressures and preclude land subsidence and lowering of the overlying fresh water table (Bureau of Reclamation, 1972). The high pressures and temperatures and the corrosiveness of the injected fluid are special sources of problems in such injection wells.

b. Injection Wells Related to Oil and Gas Production. Oil-field brines are introduced into the subsurface through wells used for secondary recovery by water flooding and through wells that are for disposal only, with no economic purpose. Some brine-disposal pits are also still used, although this practice has been greatly limited in recent years.

Table 3 shows the disposition of produced oil-field waters in 1963. It can be seen from Table 3 that about 72 percent of produced brine was reinjected in 1963, about 12 percent was disposed to unlined pits, and 16 percent by other methods. The percent injected would be expected to be greater today because, since 1963, several major oil-producing States, including Texas, have virtually banned unlined pits. Recent information obtained by EPA shows that a total of about 40,000 secondary recovery wells and 8,000 brine-disposal wells exist in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. Perhaps another 20,000 secondary recovery wells and 2,000 brine-disposal wells exist in other States.

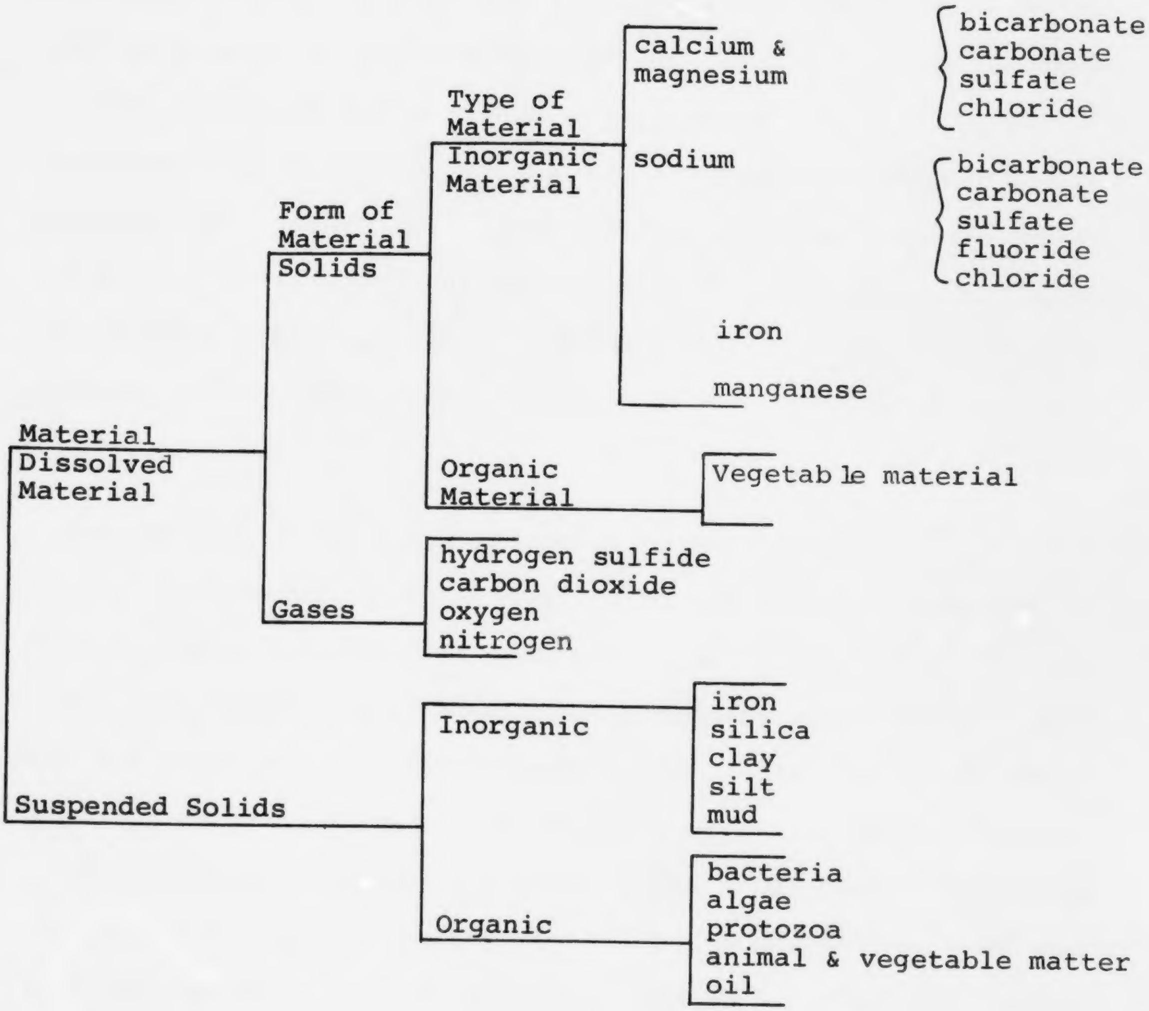
The mechanisms for potential contamination of ground water from oil-field brine injection wells are essentially the same as those discussed for other industrial disposal wells. Table 4 shows the types of dissolved and suspended solids in brines. Incompatibility of these constituents with the soils and native aquifer waters can cause chemical precipitation and

Table 3. - DISPOSITION OF PRODUCED OILFIELD WATER IN 1963
(Figures in barrels per day,
Interstate Oil Compact Commission, 1963)

	Current Volumes Produced	INJECTION		Impervious Pits	Unlined Pits	Streams and Rivers	Other Methods
		For Water Flood	For Disposal Only				
ALABAMA	2,493		1,397		493	603	
ALASKA	1,128		1,128				
ARIZONA	100				100		
ARKANSAS	539,132	89,082	340,734		7,444	101,871	
CALIFORNIA	2,740,850	445,768	208,665	3,127	399,933	501	(1) 825,410 (2) 99,168 (3) 758,277
COLORADO	202,194	131,500	5,000	70	65,624		
FLORIDA(7)	600		600				
GEORGIA (7)							
IDAHO (7)							
ILLINOIS	876,712						(4) 876,712
INDIANA	81,797	50,960	14,724		15,132		(5) 982
KANSAS	5,011,400	800,000	4,200,000	1,800	9,600		
KENTUCKY	123,287	73,973	35,616	2,740	5,480	5,480	
LOUISIANA	2,785,000	184,000	1,762,000		698,000		(1) 141,000
MARYLAND (7)							
MICHIGAN	149,587		147,849		982		(6) 756
MISSISSIPPI	340,079	40,000	203,836	8,219	74,329		(5) 13,699
MISSOURI (7)							
MONTANA	50,000	10,000	31,400		8,600		
NEBRASKA	121,907	17,329	7,567		97,011		
NEVADA (7)							
NEW MEXICO	356,624	55,176	165,423		136,025		
NEW YORK (7)							
NORTH DAKOTA	31,000	23,500			7,500		
OHIO (7)							
OKLAHOMA	3,751,911	3,160,577	583,280	5,370	2,685		
OREGON (7)							
PENNSYLVANIA	191,780					191,780	
SOUTH DAKOTA	68				68		
TENNESSEE (7)							
TEXAS	6,127,671	2,736,755	1,472,954		1,262,719	615,566	(5) 39,677
UTAH	81,634	2,981			4,862		(3) 73,790
VIRGINIA (7)							
WASHINGTON (7)							
WEST VIRGINIA	115,068					115,068	
WYOMING (7)							
	23,682,022	7,821,601	9,182,173	21,326	2,796,587	1,030,869	2,829,471

(1) To Nonpotable Water Body
(2) Disposal at Sites Approved by Regulatory Agency
(3) Fresh Water Used for Irrigation and Livestock
(4) Unknown Disposition
(5) Unaccounted
(6) Lease Operations and Dust Control on County Roads
(7) Either/or No Report, no Production, No Information Available

Table 4 . - COMMON IMPURITIES IN BRINE
(After Reid and others, 1974)


Material
Dissolved
Material
Form of
Material
Solids
Type of
Material
Inorganic
Material
calcium &
magnesium
bicarbonate
carbonate
sulfate
chloride
sodium
bicarbonate
carbonate
sulfate
fluoride
chloride
iron
manganese
Organic
Material
Vegetable material
Gases
hydrogen sulfide
carbon dioxide
oxygen
nitrogen
Suspended Solids
Inorganic
iron
silica
clay
silt
mud
Organic
bacteria
algae
protozoa
animal & vegetable matter
oil

clogging of aquifers during underground injection. Table 5 lists some of the treatment methods for removing or reducing the harmful effects of undesirable constituents in brine before injection. Spillage problems can be handled in part by suitable "housekeeping" procedures. Because oil-field brine is a natural water and does not normally contain chemicals that are extremely toxic in small quantities, in some respects it may be less of a concern as a source of contaminants from a public-health viewpoint than some other more toxic industrial waste waters. However, the extremely high content of dissolved solids that are found in many brines and the volumes involved, present the potential for degradation of very large amounts of fresh ground water if brine disposal operations are not properly managed.

It is generally believed that most brine is returned to the same geologic formation from which it was pumped. The relative amount returned to the same formation as compared with that injected into shallower formations is not known, but substantial amounts are injected into formations that have not been depressured by petroleum production. An example of this is the injection of oil-field brines into the Glorieta Sandstone in the Oklahoma Panhandle and adjacent areas (Irwin and Morton, 1969). The hazard from this practice is from interaquifer flow of brine, or alteration of the position of the fresh water-salt water interface.

Table 5. - UNDESIRABLE WASTE CHARACTERISTICS IN BRINE AND REMOVAL OPERATIONS
(After Reid and others, 1974)

Undesirable Characteristics	Treatment Operations
1. Suspended Material:	
a. Oils and other floating material.	A.P.I. Separator Skimming Flotation
b. Solids, colloids, etc.	Chemical coagulation Sedimentation Centrifugation Gravity Sand Filtration Pressure Sand Filtration Diatomite Filtration
c. Biological growths (e.g., slime-forming algae and bacteria)	Chlorination Filtration
2. Dissolved Substances:	
a. Gases	Aeration Purging Vacuum Degasifer
b. Undesirable ions	pH Adjustment Neutralization Precipitation, Chemical Coagulation Ion Exchange Membrane Process
3. Corrosiveness:	Removal of Gases pH Control

The widespread existence of ground-water contamination by oil-field brine is indicated by the results of a recent survey of the Interstate Oil Compact Commission in which it was found that 22 of the oil-producing States reported having some ground-water contamination problems (Interstate Oil Compact Commission, 1974). The reply from the State of New Mexico is quoted below, because it was the most descriptive given:

> "(1) The primary problem related to salt-water production in New Mexico is the volume of such production. Salt-water production has increased from 43,170,000 barrels in 1955 to 219,378,000 barrels in 1973, off 28,379,000 barrels from 1970, the year of highest production. About 90% of this water production is from pools in Southeast New Mexico where it is most often produced in areas having shallow fresh water. Surface disposal of such produced waters can adversely affect fresh water and its use for human consumption, stock watering, or industrial purposes.
>
> (2) Operators of some salt-water disposal wells have permitted equipment to deteriorate and fail in such wells without notification to the Commission, without attempting repair work, and without suspending disposal operations. In situations such as this, contamination of fresh waters could result, the well can be rendered in such condition as to prevent proper plugging of the same, and formations other than the injection zone may be pressured up with salt water.
>
> (3) Some operations are carried out in non-compliance with Commission rules prohibiting surface disposal of salt water. These range from plain sloppy operations to outright knowing violations of the rules.
>
> (4) In some older areas where surface disposal of substantial volumes of salt water took place prior to its prohibition, certain domestic and stock wells have exhibited signs of salt-water contamination months or years after discontinuance of surface-disposal."

c. Drainage Wells

In the Snake River Plain of Idaho and in parts of Florida and elsewhere, wells are commonly used to dispose of urban runoff drainage and excess irrigation or agricultural drainage water to shallow aquifers. In Table 2, it is indicated that there may be 50,000 drainage wells used for disposal mainly of storm-water runoff, and agricultural waste waters.

Storm-water runoff generally has a low dissolved-solids content. However, the initial slug of storm water may be contaminated with animal excrement, traces of pesticides, fertilizer nitrate from lawns, organics from combustion of petroleum products, rubber from tires, bacteria, viruses, and other miscellaneous contaminants. Where deicing salts are applied to roads in the winter, the chloride content of storm-water runoff may rise temporarily to as much as several thousand milligrams per liter.

Efforts have been made for many years to discourage the use of wells that inject municipal, industrial, and agricultural wastes into fresh-water aquifers. Therefore, it is anticipated that the number of such wells will diminish with time.

2. Use of Ground Water. Ground water is obtained almost entirely from wells that penetrate permeable unconsolidated sediments or rocks known as aquifers. A relatively small amount of ground water issues directly from springs or seeps fed by such aquifers. The most prolific aquifers in the nation are composed of the beds of sand and gravel, and of rocks such as limestone, lava, and sandstone. Dense rocks like granite and gneiss generally yield relatively small amounts of water to wells, but are of considerable importance for domestic supplies in areas where other aquifers are not present. Most water wells are less than a few hundred feet deep, but some in Atlantic Coastal Plain areas, for example, extend to depths of 2,500 feet.

Almost all ground water originates from precipitation and is part of the hydrologic cycle (Figure 7). Initially, the water percolates downward through soil and rock layers until it reaches the water table, which is the upper surface of the saturated zone. This water then moves slowly (generally at rates of a few feet per day to a few feet per year), either to a natural discharge outlet such as a stream, a spring, a lake, or the sea, or to a man-made outlet, such as a drain or well.

Typically, natural ground water contains some dissolved salts, which originate mainly in the source water (precipitation) and by solution of the rocks through which the ground water moves.

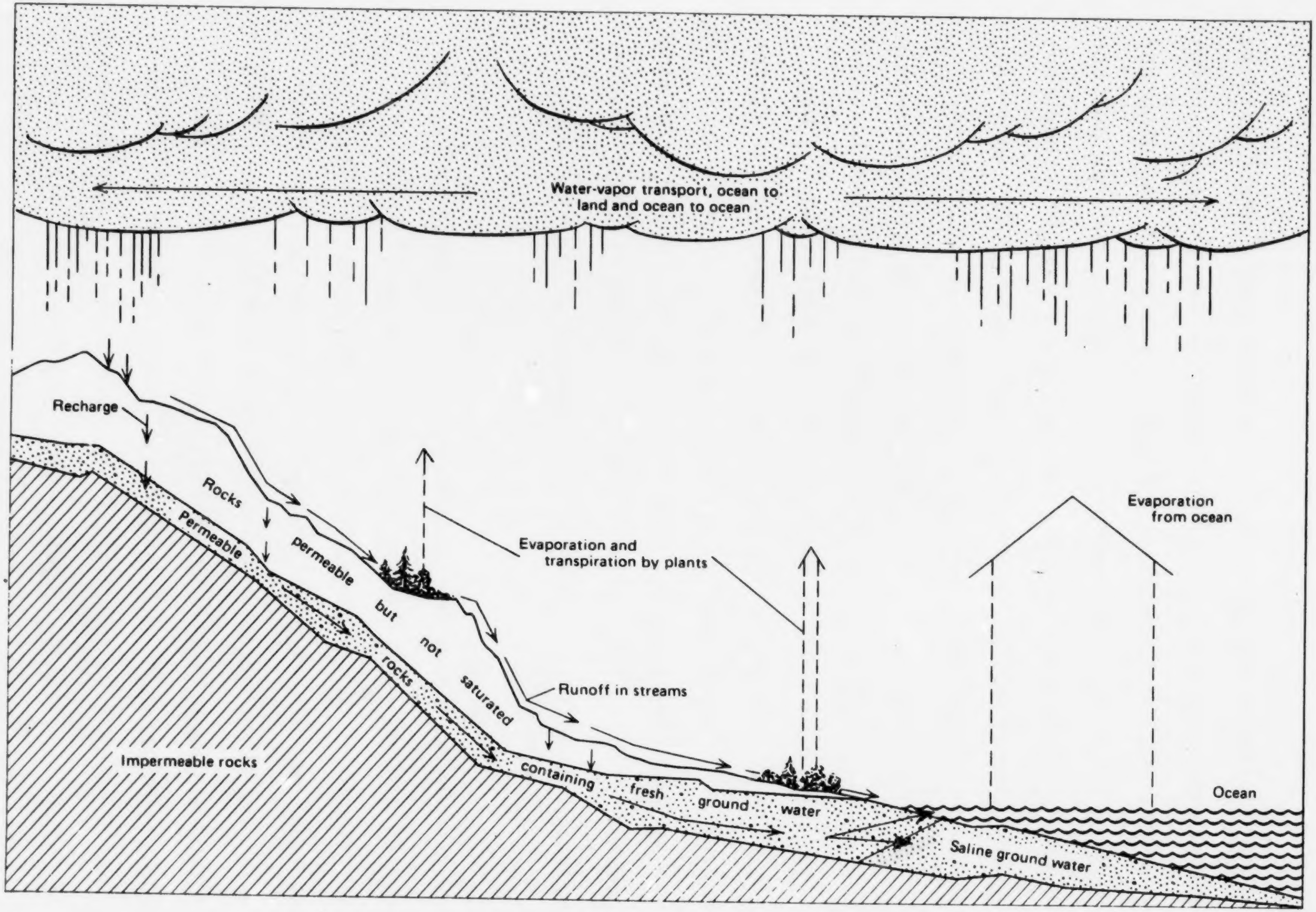
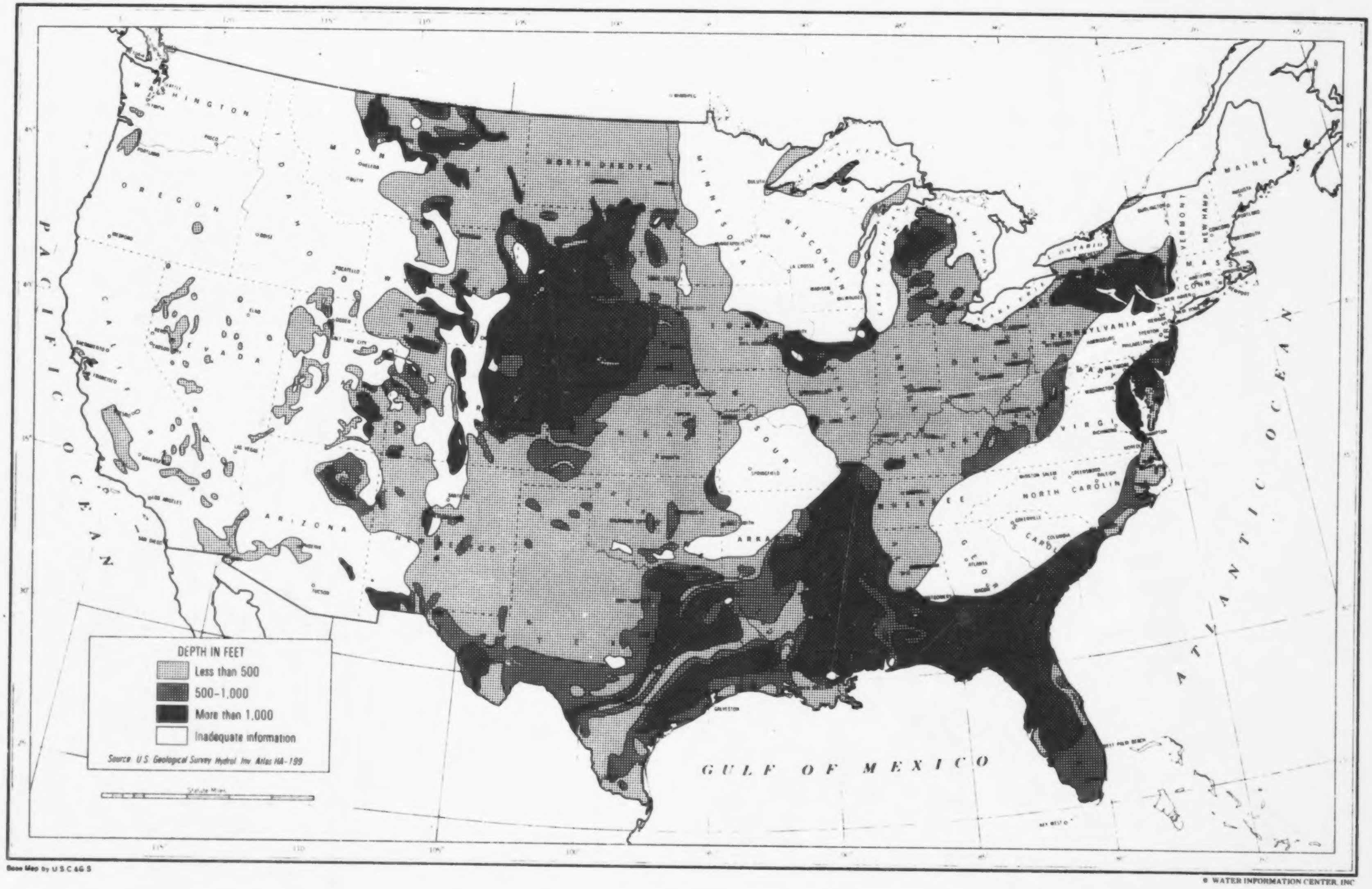

Water-vapor transport, ocean to land and ocean to ocean
Recharge
Rocks permeable but not saturated
Permeable rocks containing fresh ground water
Evaporation and transpiration by plants
Runoff in streams
Evaporation from ocean
Ocean
Saline ground water
Impermeable rocks

Figure 7. Sketch of Earth's Water Cycle.

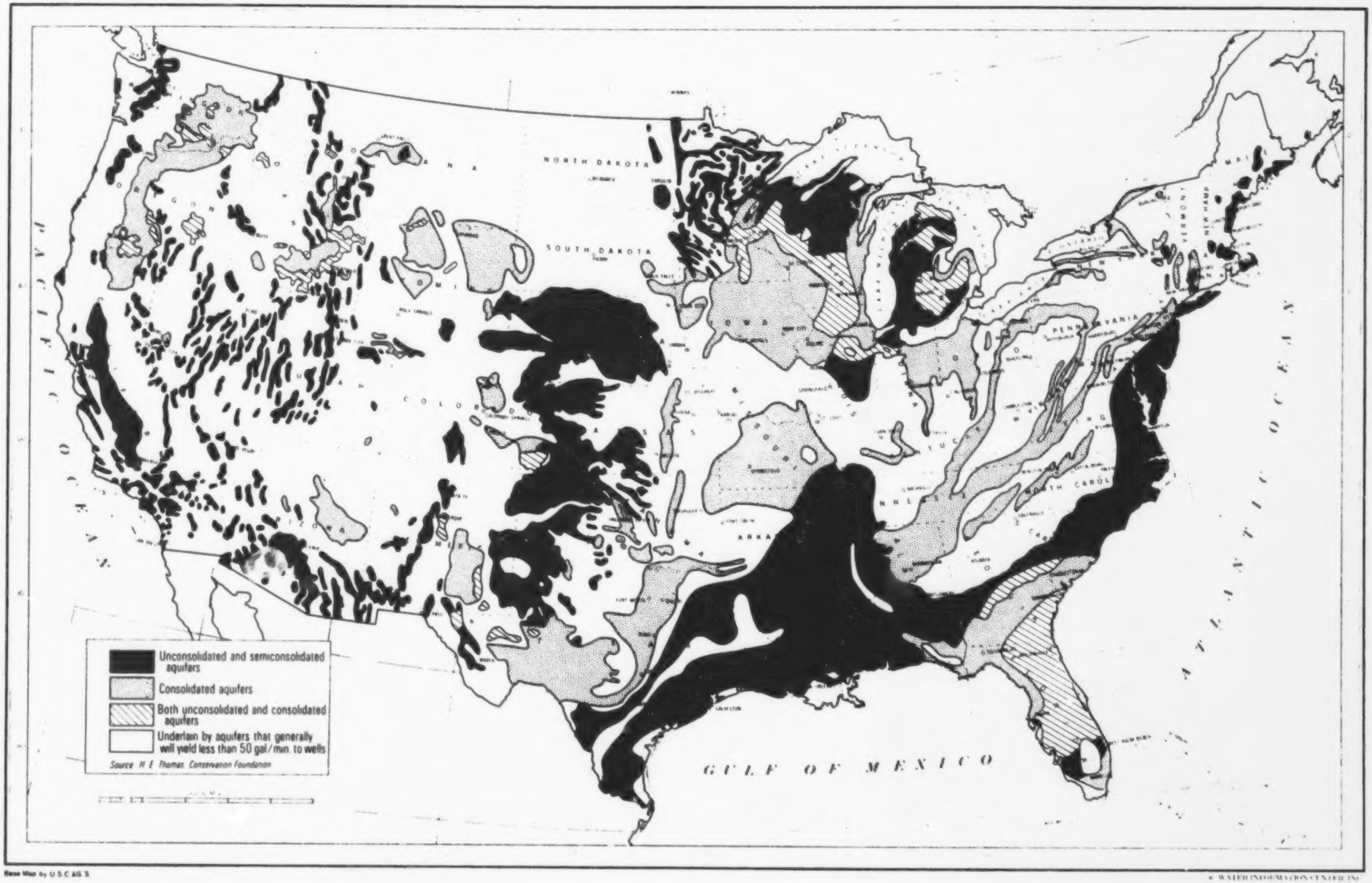
Limestone aquifers, for example, contribute high concentrations of calcium and magnesium that cause water to be hard and, therefore, undesirable for domestic and industrial water use without treatment. Other aquifers may contribute salts, such as sulfate and chloride, traces of metals, silica, and a host of other constituents, but generally in small amounts. Except for some dissolved constituents, such as high concentrations of fluoride and iron, deep brine (Fig. 8), and salty ground water bordering coastal areas, the quality of most natural ground water is generally suitable for drinking water. Only the activities of man, such as disposal of fluids underground and overpumping of freshwater aquifers, introduce large quantities of poor quality fluids that cause degradation of ground-water quality. One of the major objectives of the proposed regulations is to bring under better control activities that lead to ground-water contamination.

Locations of major unconfined and confined aquifers in the United States are shown on Figure 9 . Most of these are areally extensive water-bearing units in contrast to the long, narrow sand and gravel aquifers that are hydraulically interconnected to major streams, as shown on Figure 10. The buried river valley deposits are typically highly productive because pumping wells near the streams normally induce water movement from the streams into the aquifers. This can also be a mechanism for contaminating aquifers which are interconnected with contaminated stream water.



DEPTH IN FEET
Less than 500
500-1,000
More than 1,000
Inadequate information
Source U.S. Geological Survey Hydrol. Inv. Atlas HA-199
Statute Miles
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
WASHINGTON
OREGON
MONTANA
IDAHO
NEVADA
ARIZONA
NORTH DAKOTA
MINNESOTA
WISCONSIN
MISSOURI
ARKANSAS
PENNSYLVANIA
VIRGINIA
NORTH CAROLINA
VERMONT
NEW HAMP
MAINE
MASS
CONN
LAKE MICHIGAN
Base Map by U.S.C.&G.S.
© WATER INFORMATION CENTER, INC.

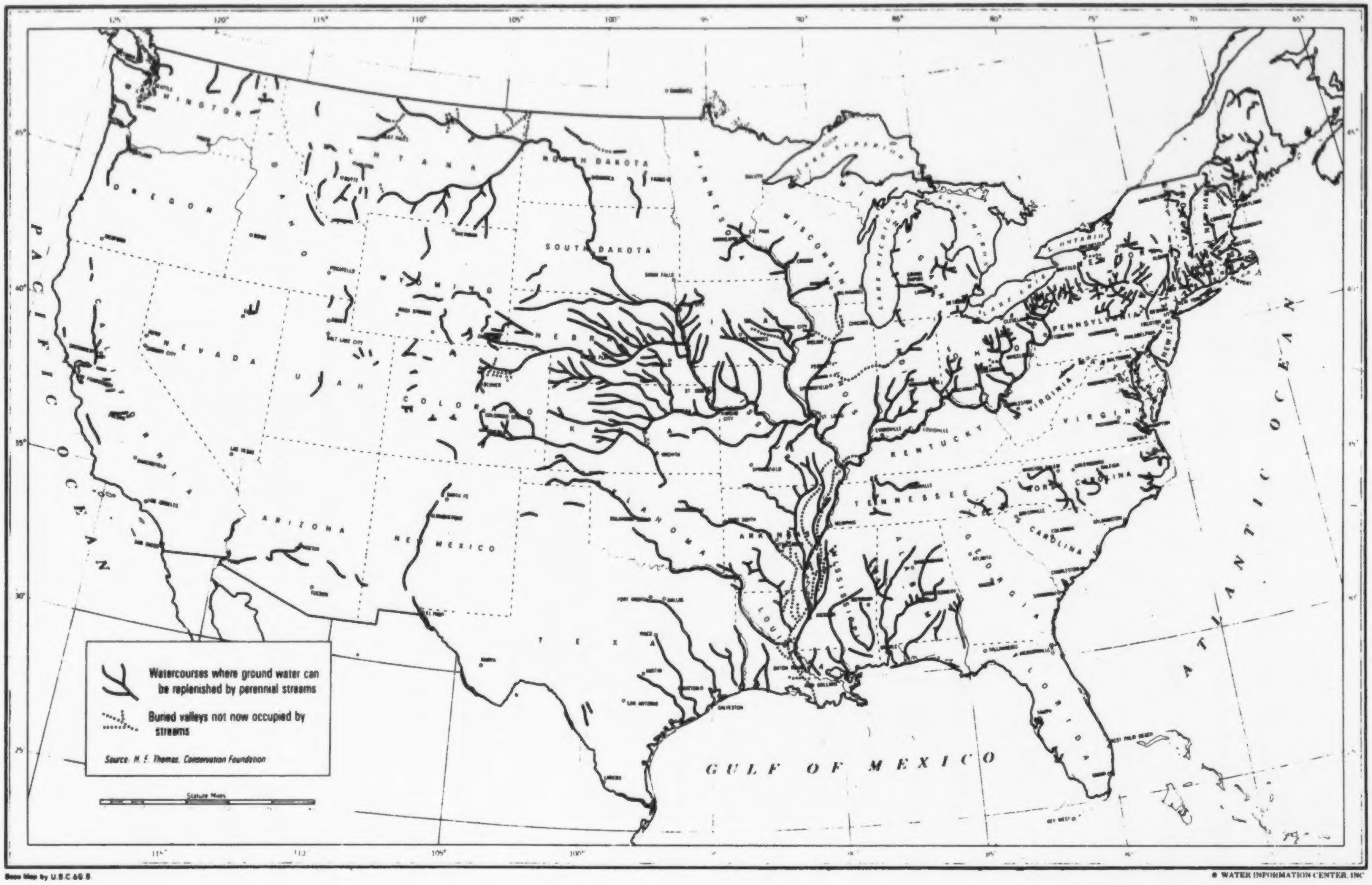
Figure 8. Depth to Saline Ground Water (Total Dissolved Solids 1,000 mg/l or More) (after Geraghty and others, Water Atlas, 1973).


PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
NORTH DAKOTA
SOUTH DAKOTA
OREGON
COLORADO
PENNSYLVANIA
VERMONT
NEW HAMP
Unconsolidated and semiconsolidated aquifers
Consolidated aquifers
Both unconsolidated and consolidated aquifers
Underlain by aquifers that generally will yield less than 50 gal/min. to wells
Source: H. E. Thomas, Conservation Foundation

Base Map by U S C & G S

© WATER INFORMATION CENTER INC

Figure 9. Major Aquifers of the United States (after Geraghty and others, Water Atlas, 1973).


Watercourses where ground water can be replenished by perennial streams
Buried valleys not now occupied by streams
Source: H. E. Thomas, Conservation Foundation
Statute Miles
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
WASHINGTON
OREGON
IDAHO
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
NEVADA
UTAH
WYOMING
COLORADO
ARIZONA
NEW MEXICO
TEXAS
OKLAHOMA
KANSAS
MINNESOTA
WISCONSIN
IOWA
MISSOURI
ARKANSAS
LOUISIANA
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
TENNESSEE
KENTUCKY
OHIO
INDIANA
ILLINOIS
MICHIGAN
PENNSYLVANIA
NEW YORK
VIRGINIA
WEST VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
NEW JERSEY
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
125°
120°
115°
110°
105°
100°
95°
90°
85°
80°
75°
70°
65°
45°
40°
35°
30°
25°

Base Map by U.S.C.&G.S.

© WATER INFORMATION CENTER, INC

Figure 10. Narrow Aquifers Related to River Valleys in the United States (after Geraghty and others, Water Atlas, 1973).

Ground water is widely used throughout the United States for public-water supplies, rural (domestic) use, irrigation, and industrial water supplies. Figure 11 shows comparative ground-water and surface-water use by States in 1970, and Figure 12 shows ground-water use as a percent of total water use, by States, in 1970.

About 21 percent of all the fresh water supplied in the United States for all purposes except the generation of hydroelectric power originates from ground water. More importantly, ground water provides 36 percent of all irrigation water and 96 percent of all rural (domestic) water use in the country. Ground water is the source of supply for more than 100 million people, of which 60 million are served by public-supply systems. Ground water also constitutes about 25 percent of the fresh water used by industries dependent on their own water-supply facilities.

The water-well industry in the United States is a large and growing industry. There are some 15,000,000 municipal, industrial, commercial, agricultural, and domestic water wells in the country that have been constructed by some 6,000 licensed water-well drilling contractors. The capital investment in these water wells approximates 15 billion dollars, and nearly 500,000 new water wells are drilled each year.

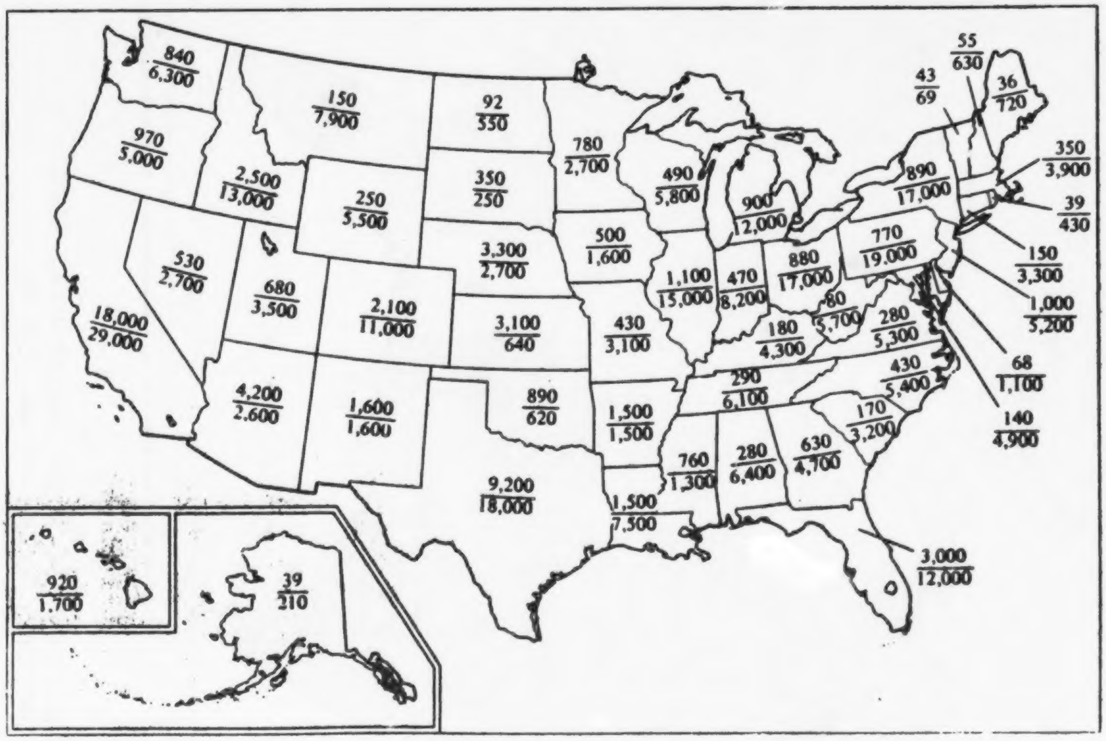

840
6,300
970
5,000
150
7,900
92
350
2,500
13,000
250
5,500
350
250
780
2,700
490
5,800
900
12,000
890
17,000
43
69
55
630
36
720
350
3,900
39
430
18,000
29,000
530
2,700
680
3,500
2,100
11,000
3,300
2,700
3,100
640
500
1,600
430
3,100
1,100
15,000
470
8,200
880
17,000
770
19,000
150
3,300
1,000
5,200
80
5,700
180
4,300
280
5,300
68
1,100
4,200
2,600
1,600
1,600
890
620
1,500
1,500
290
6,100
430
5,400
140
4,900
170
3,200
760
1,300
280
6,400
630
4,700
9,200
18,000
1,500
7,500
3,000
12,000
920
1,700
39
210

Figure 11. Ground-Water Withdrawals (Upper Figure) and Surface-Water Withdrawals (Lower Figure), in Million Gallons Per Day, by States, 1970 (after Murray and Reeves, 1972).

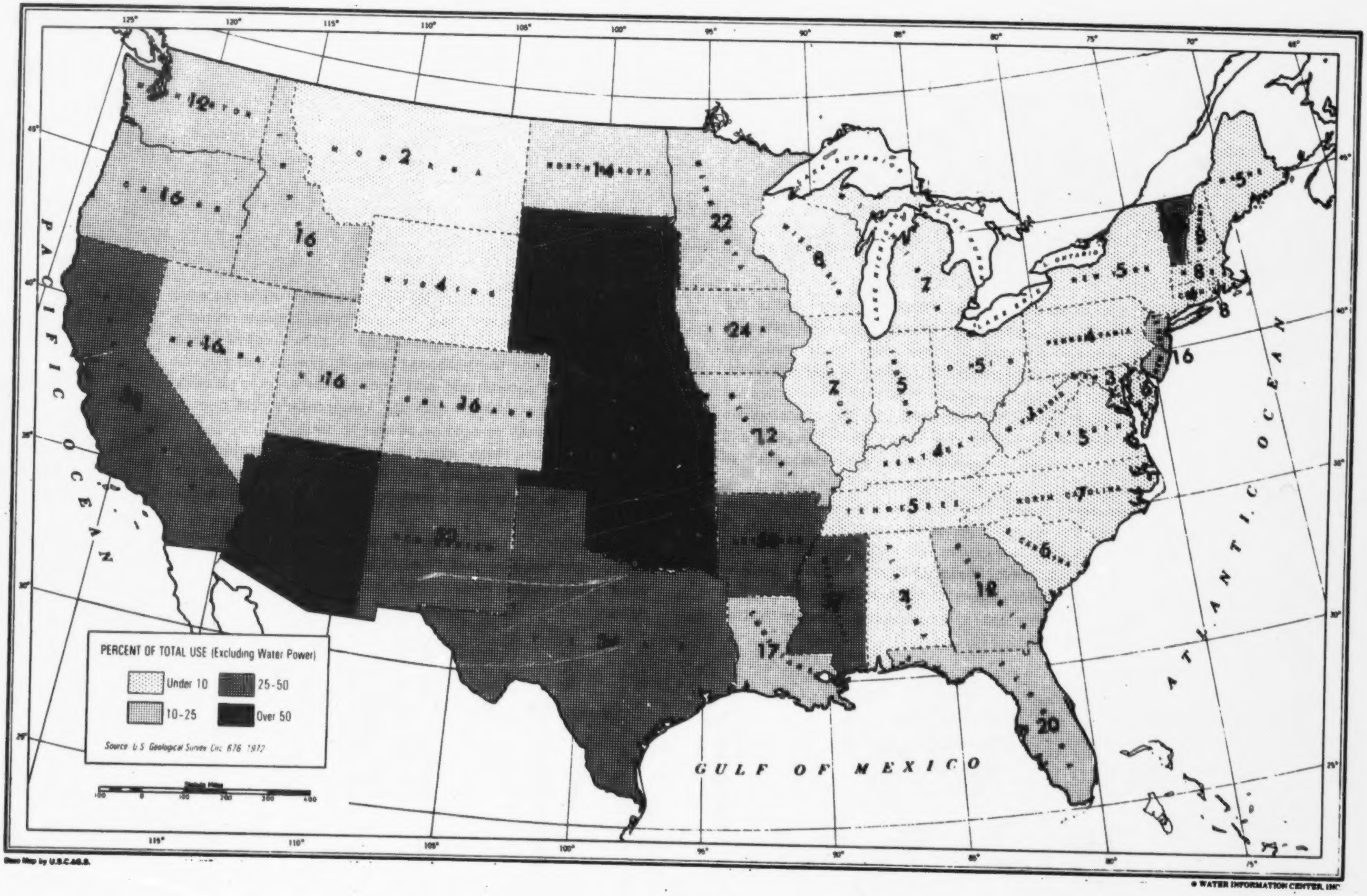
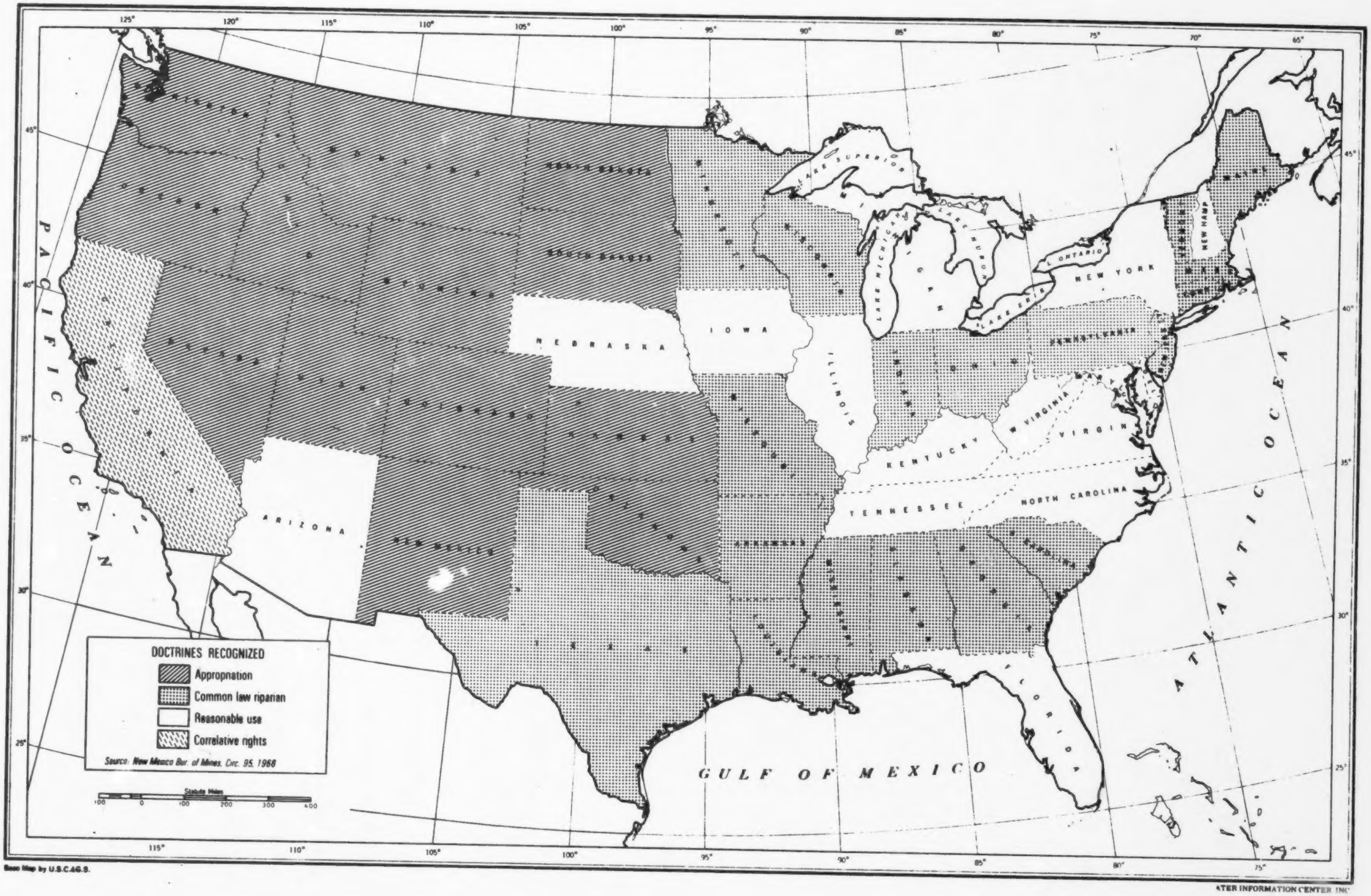

PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
PERCENT OF TOTAL USE (Excluding Water Power)
Under 10
10-25
25-50
Over 50
Source: U.S. Geological Survey Circ. 676, 1972
Base Map by U.S.C.&G.S.
© WATER INFORMATION CENTER, INC.
12
16
16
2
4
16
16
16
14
22
24
12
17
8
7
7
5
5
4
5
4
3
5
7
6
12
20
5
8
8
8
16
3
6

Figure 12. Ground-Water Use as Percent of Total Water Use, 1970 (after Geraghty and others, Water Atlas, 1973).

3. Existing State Injection Regulations and Programs.

a. Variation in Scope and Type of Regulatory Controls. Legal controls and procedures regarding ground-water use and contamination differ widely among the States in the scope of activities covered and in the type and quantity of information and monitoring requirements, if any, needed to comply with State regulations (Figures 13 and 14 and Tables 6 and 7). Moreover, there is an equally wide range in overlapping jurisdictions and in the assignment of primary responsibilities to different agencies, which bears on their effectiveness in dealing with ground-water contamination. Only about one-fourth of the States have water statutes or laws dealing specifically and in detail with ground-water quality. However, many States have miscellaneous legislation or controls which might enable them to take direct or indirect action to protect ground-water quality after a problem has been brought to their attention. In a few States, individual towns or counties have more stringent regulations than State-wide laws.

This section is based in part on a review of summary reports (see References) on the existing body of published water laws, water-pollution laws, solid-waste regulations, and miscellaneous codes and ordinances. It does not include a review of the large body of law based on decisions and interpretations of the courts. The term "statute, act, or law" generally refers to a legislative enactment by a Federal or State legislative body. An


DOCTRINES RECOGNIZED
Appropriation
Common law riparian
Reasonable use
Correlative rights
Source: New Mexico Bur. of Mines, Circ. 95, 1968
Statute Miles
100 0 100 200 300 400
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
NEBRASKA
IOWA
ILLINOIS
ARIZONA
KENTUCKY
TENNESSEE
NORTH CAROLINA
VIRGINIA
W. VIRGINIA
NEW YORK
PENNSYLVANIA
NEW HAMP
FLORIDA
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
ONTARIO
125° 120° 115° 110° 105° 100° 95° 90° 85° 80° 75° 70° 65°
45° 40° 35° 30° 25°

Base Map by U.S.C.&G.S.

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Figure 13. Types of Ground-Water Laws, by States (after Geraghty and others, Water Atlas, 1973).

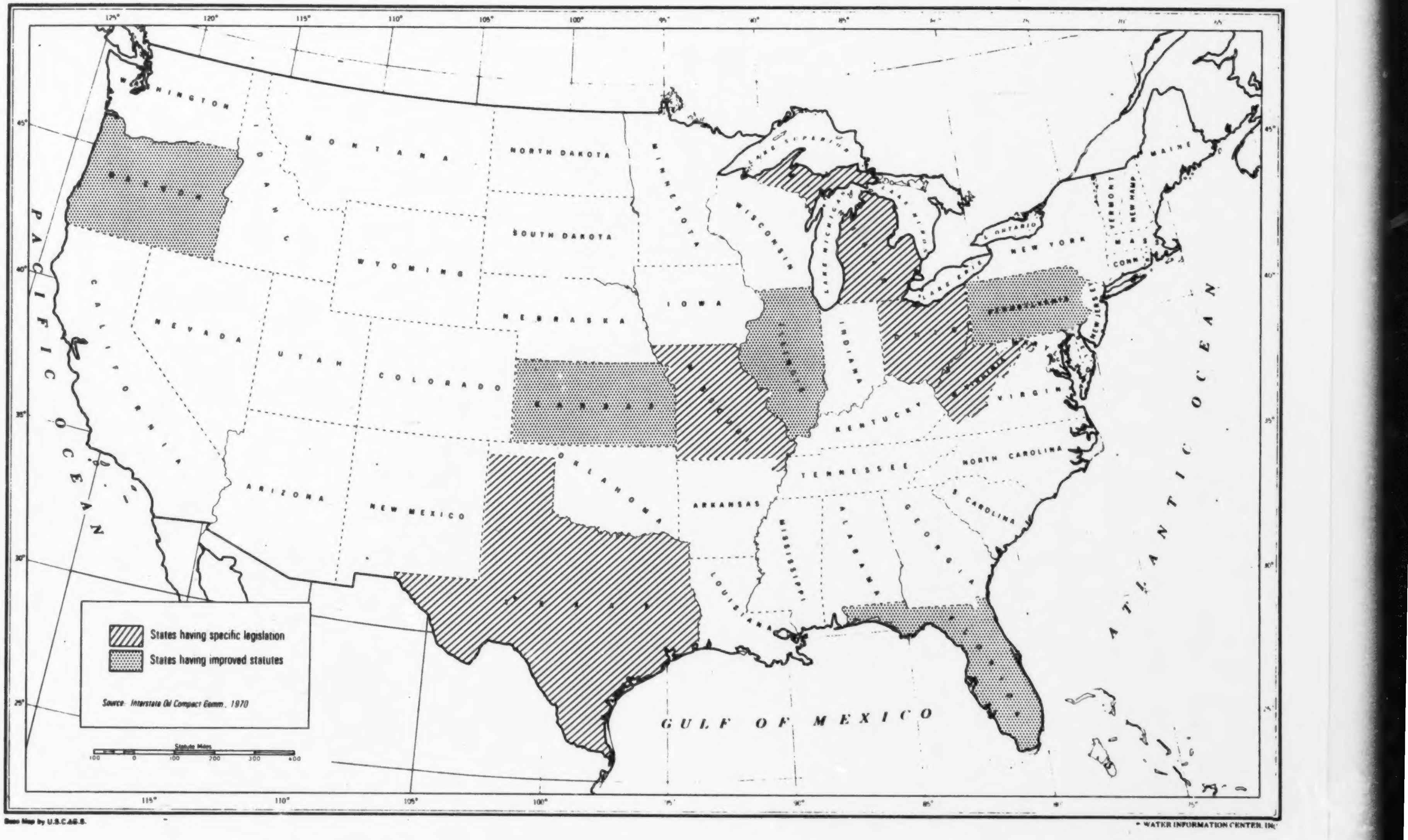

WASHINGTON
OREGON
IDAHO
MONTANA
WYOMING
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
MINNESOTA
WISCONSIN
IOWA
ILLINOIS
INDIANA
MICHIGAN
OHIO
PENNSYLVANIA
NEW YORK
VERMONT
NEW HAMP
MAINE
MASS
CONN
NEW JERSEY
WEST VIRGINIA
VIRGINIA
KENTUCKY
TENNESSEE
NORTH CAROLINA
S CAROLINA
GEORGIA
FLORIDA
ALABAMA
MISSISSIPPI
LOUISIANA
ARKANSAS
MISSOURI
KANSAS
OKLAHOMA
TEXAS
NEW MEXICO
COLORADO
UTAH
NEVADA
CALIFORNIA
ARIZONA
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
ONTARIO
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
▨ States having specific legislation
▩ States having improved statutes
Source: Interstate Oil Compact Comm., 1970
Statute Miles
100 0 100 200 300 400
125° 120° 115° 110° 105° 100° 95° 90° 85° 80° 75° 70° 65°
45° 40° 35° 30° 25°
Base Map by U.S.C.&G.S.
© WATER INFORMATION CENTER, INC.

Figure 14. Conventional Injection Well Laws, by States (after Geraghty and others, Water Atlas, 1973).

ordinance or code is commonly issued by a county or other local government body. In most States, contamination controls are mainly in the form of rules or regulations (see Tables I, II, and III Appendix), are based on administrative actions, or are issued by a local regulatory agency. In some States rules, regulations, standards, and codes have been adopted also by legislative bodies which gives them a somewhat higher legal status.

Many States have general statutory controls covering protection of ground-water quality which are supplemented by administrative rules and regulations to cover specific forms of injection such as industrial and municipal disposal wells and landfills. Although some States have detailed statutes, they give wide discretionary authority in enforcement to regulatory bodies.

Policy statements are also used by some States to guide or control injectors. For example, Virginia has issued a policy statement which expresses opposition to the concept of disposal wells whereas the Ohio River Valley Water Sanitation Commission has issued a positive statement on disposal wells (see section on "Disposal Wells").

b. State Water and Water Pollution Laws. Most State water laws deal entirely or almost entirely with protection of surface-water quality and rarely mention ground water or ground-water contamination. Commonly, the only reference to ground water is to include the term in the general definition of "Waters of the State." In several States, various specific exclusions from the definition tend to weaken the opportunity for controls. For example, water confined and retained on private property such as ponds or lakes, which do not constitute a hazard to fish and wildlife, are specifically excluded from the definition in some States. In West Virginia, farm ponds, industrial basins, and water-treatment facilities are excluded. Other exclusions in some States are gas and oil wells, disposal wells, and retention ponds, and copper and iron mining operations.

Many State water statutes attempt to deal with ground-water contamination superficially or indirectly through well-construction standards, requirements for sealing abandoned wells, and groundwater quality standards as shown in Table 6. Only three States, Indiana, Kansas, and Pennsylvania, refer to proper construction, drilling, and operation of oil and gas wells in their water statutes, but in other States these types of activities commonly are covered by other statutes, such as the Texas Railroad Commission Acts and the California Public Resources Code.

Industrial and municipal disposal wells are referred to in water statutes in about 12 States. Such disposal is generally permitted under certain restrictions and requirements such as no disposal into aquifers suitable for public or domestic supply, chemical and bacteriological sampling of wells within a given radius of the disposal well, and construction of wells in a manner which protect the water resources of the State from preventable contamination.

Table 6.-SELECTED PROVISIONS OF STATE WATER AND WATER-POLLUTION LAWS - 1972
(after Van der Leeden, 1973)

State	Water wells			Oil and gas wells		Waste wells		Other activities		
	Drillers licensed	Construction standards	Sealing abandoned wells	Construction standards	Sealing abandoned wells	Construction standards	Sealing abandoned wells	Oil-spill provision applicable	Groundwater classification issued	Mine discharge regulated
Alaska								x		
Arizona						x				
California		x	x			x	x	x		
Colorado						x				
Connecticut								x		
Delaware								x		
Florida						x[a]	x	x		
Illinois			x[b]				x[b]			
Indiana			x[c]		x[c]		x[c]			x
Kansas				x	x	x	x			
Louisiana								x		
Maine								x		
Maryland	x	x	x							
Massachusetts								x		
Michigan										x
Minnesota								x		
Missouri						Prohibited				
New Jersey								x		
New York									x	
Oklahoma			x			Prohibited				

Table 6 (continued). SELECTED PROVISIONS OF STATE WATER AND WATER-POLLUTION LAWS - 1972

State	Water wells			Oil and gas wells		Waste wells		Other activities		
	Drillers licensed	Construction standards	Sealing abandoned wells	Construction standards	Sealing abandoned wells	Construction standards	Sealing abandoned wells	Oil-spill provision applicable	Groundwater classification issued	Mine discharge regulated
Oregon								x		
Pennsylvania		x[d]		x[d]		x		x		
Texas						x[e]				
Washington								x		
West Virginia						x				
Wisconsin		x[f]								

[a] Secondary waste treatment prior to discharge into injection well mandatory; at least 90% (organic removal) treatment to be provided.

[b] Pollution Control Board authorized to promulgate standards for filling or sealing of abandoned water wells and holes for disposal of drainage.

[c] State Stream Pollution Control Board has power to require sealing of mines, oil & gas wells, brine wells or any other subterranean strata.

[d] Regulations primarily affect well drilling operations and prevention of pollution from discharge of mud, oil, and salt water on land surface.

[e] Design report required for earthen lagoons, and storage pits to determine whether ground-water contamination will occur.

[f] Permit required for water wells if rate of withdrawal is in excess of 100,000 gallons per day.

(1) Water-Well Regulations. Licensing of well-drillers and the application of selected well-construction standards as described in State water-well regulations provide some direct or indirect protection against ground-water contamination. Table 7 shows the wide range in requirements for licensing and well construction standards by States in 1972.

Construction of public-supply wells is controlled in all States, but in about one-third of the States, domestic, irrigation, and industrial water wells either are not controlled or the requirements for drilling and operating of such wells are minimal. Plugging and sealing of abandoned wells, an important method of preventing ground-water contamination, is provided for by generalized or specific regulations in only about 30 States. Recharge wells are regulated in only 18 States.

(2) Disposal Wells. Texas, Ohio, Michigan, and Idaho are among the few States that have specific statutes on conventional disposal wells. The Texas law passed in 1961 and amended in 1969 requires a permit from the Water Quality Board. Applications are also sent to the Water Development Board, Department of Health, and Water Well Drillers Board, and public hearings may be held. The Texas Railroad Commission requires a letter from the injector stating that the proposed well will not interfere with or endanger any oil or gas formation. The Water Quality Board may adopt rules, regulations, and procedures to control disposal wells.

Table 7.-SUMMARY OF SELECTED PROVISIONS OF WATER-WELL REGULATIONS BY STATE, 1972

(X, regulation applies; ----, information not available)
(Van der Leeden, 1973)

State	Drillers Licensed	Well Construction Regulations				Plugging and Sealing Regulations		Recharge Wells Regulated
		Public Water Supply	Domestic	Irrigation	Industrial	Abandoned Wells	Contaminated Zones	
Alabama	----	----	----	----	----	----	----	----
Alaska		X		X	X			X
Arizona		X				X	X	X
Arkansas	X	X	X	X	X	X	X	X
California	X	X	X	X	X	X	X	X
Colorado	X	X	X	X	X	X	X	X
Connecticut	X	X	X	X	X			
Delaware	X	X	X	X	X	X	X	----
Florida	X	X	X	X	X	X	X	X
Georgia		X				X		X
Hawaii				No Regulations				
Idaho	X			No Regulations				
Illinois	X	X	X			X	X	X
Indiana	X	X				X	X	X
Iowa				No Regulations				
Kansas	X	X	----	----	----	X	X	----
Kentucky	----	----	----	----	----	----	----	----
Louisana	----	----	----	X		X	X	X
Maine				No Regulations				
Maryland	X	X	X	X		X	X	
Massachusetts				No Regulations				
Michigan	X	X	X	X	X	X		X
Minnesota	X	----	----	----	----	----	----	----
Mississippi	X	----	----	----	----	----	----	----
Missouri		X				X		
Montana	X	X				X	X	
Nebraska		X		X	X	X		
Nevada	X	X	X	X	X	----	----	X
New Hampshire				No Regulations				
New Jersey	X	X	X	X	X	X	X	X
New Mexico	X [a]	X		X [a]	X [a]	X [a]		
New York	X [a]			No Regulations				X [a]
North Carolina	X	X	X	X	X	X	X	X
North Dakota	X	X	X	X	X	X	X	
Ohio	----	----	----	----	----	----	----	----
Oklahoma	X [b]	X	X	X	X	X	X	X
Oregon	X	X	X	X	X	X	X	
Pennsylvania	X	X				X		
Rhode Island	X			No Regulations				
South Carolina				No Regulations				
South Dakota	X	X		X	X	X		X
Tennessee	X	X	----	----		X	X	
Texas	X	X		X	X	X	X	X
Utah	X	X	X	X	X	X	X	
Vermont	X			No Regulations				
Virginia				No Regulations				
Washington				No Regulations				
West Virginia		X		----	----	X	X	
Wisconsin	X		X			X		
Wyoming		X	X	X		X	X	

[a] Applies to designated areas only

[b] As of July 1, 1973

In 1967, Ohio changed its Oil and Gas Code to include industrial waste disposal wells in addition to brine wells. Authority is vested in the Division of Oil and Gas of the Department of Natural Resources under a permit system. The permit must also be approved by the Water Pollution Control Board, the Department of Health, and the Geological Survey. Also, if the well is in a coal-bearing area, it must be approved by the Division of Mines. Requirements for construction and abandonment procedures are the same as for oil and gas wells.

A small number of States rely on general pollution control and oil and gas laws to control industrial waste injection. North Carolina and Missouri prohibit municipal and industrial disposal wells under statutory regulations.

Comprehensive administrative regulations on disposal wells exist in Colorado, Hawaii, Louisiana, Michigan, Nebraska, and Oklahoma. The Colorado regulations (Table I, Appendix) are partly patterned after ADS-5. Less detailed regulations exist in California and Pennsylvania. In the State of Washington, permits are required for disposal wells, and these are authorized only under extreme circumstances. Delaware and Wisconsin prohibit disposal wells by regulation.

Policy statements on subsurface injection have been issued in Alabama, Florida, Kentucky, Michigan, Mississippi, New York, Pennsylvania, and Virginia. The Ohio River Valley Water Sanitation Commission (ORSANCO) issued a policy statement on disposal wells (Table II, Appendix) in 1973. The Commission, which includes representatives from Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia, takes the position that underground injection is a technically acceptable method of waste disposal or long-term storage when regulatory agencies determine that it is the best available alternative; that the system is designed and operated properly; and that geologic and hydrologic conditions are providing protection of the natural resources.

Michigan has a Mineral Well Act (1969) that requires a permit from the Supervisor of Mineral Wells prior to drilling or deepening a disposal well. Public hearings are optional. A well constructed under a mineral well permit cannot be used for disposal unless authorized by the Water Resources Commission. The operational and monitoring requirements include at least one observation well within 100 feet of a well used for disposal or storage of radioactive materials.

(3) Oil, Gas, and Brine-Disposal Wells. References to the construction, operation, and plugging of oil and gas wells are rarely noted in State water laws. These practices are generally controlled under other statutes and codes. Commonly the statutes require sufficient casing to protect fresh water or "usable" water. In Kansas, "usable" water is defined as water containing 5,000 mg/l of chloride or less. Missouri allows return of oil-field wastes to the same oil-producing formation from which they were pumped.

Prior to 1935, discharge of oil-field brine was practiced indiscriminately and was accompanied by extensive contamination of ground and surface water. Since then, most oil-producing States have adopted some type of regulations controlling brine-disposal activities, including well injection. Table III (Appendix) summarizes the disposal requirements in some 37 States. About 28 States allow brine disposal in wells through a permit system based on State rules and regulations. In most States, the permit application proceedings require the regulatory agency to consider the suitability, legality, size, and location of the disposal well, the geologic formations encountered, and the presence of abandoned or improperly plugged wells. Generally, no public hearings are required. State regulatory agencies also maintain records of secondary recovery of oil by injection of brines through wells to displace the remaining oil in a reservoir. Some States do not charge a fee for injection permits but require the posting of plugging bonds for new and oil wells or for treatment plant performance. These bonds range in amount from about $1,000 to $10,000 per well.

Review of the State regulations indicates that in many respects they include part or much of the requirements in Subpart D of the UIC regulations. However, this conformance is inconsistent among the States, and uniform control and enforcement is lacking.

(4) Solution-Mining Wells. Solution-mining wells are operated only in a small number of States such as Louisiana, Texas, Ohio, New York, Michigan, and Kansas. Although no detailed

information on control of solution-mining wells was readily available, generally, where controls exist, they are similar to those for brine-disposal or other conventional disposal wells. Michigan has a Mineral Well Act that requires a permit for drilling. In Texas, no specific legislation applies to solution mining of sulfur and salt. However, if waste products from these operations are disposed of through wells, these activities are controlled under existing industrial waste disposal regulations. For solution mining of uranium, permits, periodic reports, proper casing depths, and monitoring requirements are under the control of the Texas Water Quality Board.

(5) Other Injection Facilities. Special regulations for geothermal wells, subsidence control wells, gas-storage wells, and salt-water barrier wells are essentially nonexistent among the States. Generally, these operations are controlled under existing water-well or oil and gas regulations.

Subsidence control and salt-water barrier wells are operated in southwestern California where the Los Angeles Flood Control District reports that no special regulations exist for such wells. The problem is minimized in that area because generally potable water is being injected for control purposes. However, suitable well-construction practices are used in the design and location of the injection and observation wells to protect the fresh-water resources.

In Illinois, gas-storage well operations require approval from the Illinois Commerce Commission and permits issued by the Division of Oil and Gas include requirements for location and design of the well, geologic units, volumes of gas injected and withdrawn, and plugging and abandonment activities and bonding.

The California Division of Oil and Gas requires submission of plans for gas storage for review and approval. No actual permit is issued. Monitoring may be required to detect leakage of gas into fresh-water zones. In Texas, gas-storage injection is not closely regulated but associated brine-disposal operations are under regulations of the Texas Railroad Commission.

Geothermal wells in California are regulated by the Division of Oil and Gas under a Geothermal Code. Controls include blow-out prevention, provisions for adequate casing depth to protect fresh-water zones, and proper cement grouting of the casing. Periodic radioactive tracer tests are required to detect potential upward migration of contaminants into underground drinking-water sources.

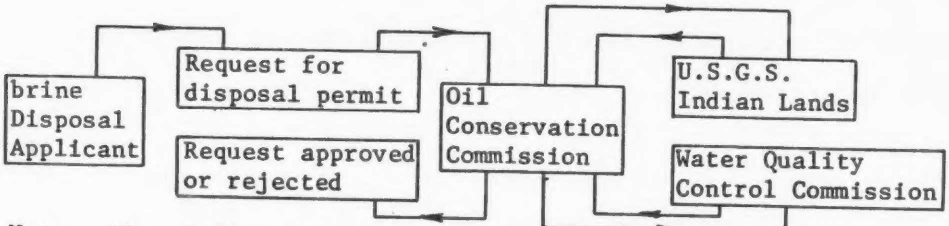
The Colorado Assembly passed a Bill in 1974 to regulate geothermal wells. The Bill extends the coverage of existing State water laws to the regulation of these wells. Permits are to be issued by the Oil and Gas Conservation Commission after an approval of such construction by the State Engineer.

c. Institutional Framework and Problems. Institutional frameworks or organizational structures for handling water pollution in general as well as injection control programs are in a state of transition. Control and supervision of these activities now is divided in different States from one department to as many as five departments.

Historically, much of this control has been relegated to State Health Departments, but in recent years, part or all of the control has been given to other agencies such as Water Resources Commissions and Departments of Pollution or Environmental Control.

Table III (Appendix) gives some indication of the multiplicity of State agencies dealing with brine disposal. Many of the same agencies also deal with other water-quality control problems. The names of the primary regulating agencies are given on the left-hand side of the table and the coordinating or cooperating agencies are listed on the right-hand side. For decisions other than brine disposal, the primary responsibility could be changed. Figure 15 shows generalized flow charts for New Mexico and Colorado which define the general steps involved in securing a permit for brine disposal. Note the participation of advisory agencies to the Oil Conservation Commission in New Mexico, including the U.S. Geological Survey, where Indian land is involved. Table IV (Appendix) lists the agencies and the numerous rules and regulations which control

NEW MEXICO


brine Disposal Applicant
Request for disposal permit
Request approved or rejected
Oil Conservation Commission
U.S.G.S. Indian Lands
Water Quality Control Commission

Note: When Indian lands are involved, the United States Geological Survey is consulted. Normally, the Water Quality Control Commission acts as consultant to the Oil Conservation Commission. The Water Quality Control Commission is made up of the heads of the Oil Conservation Commission, Department of Health and Social Services, Department of Game and Fish, Department of Agriculture, and one citizen at large.

COLORADO

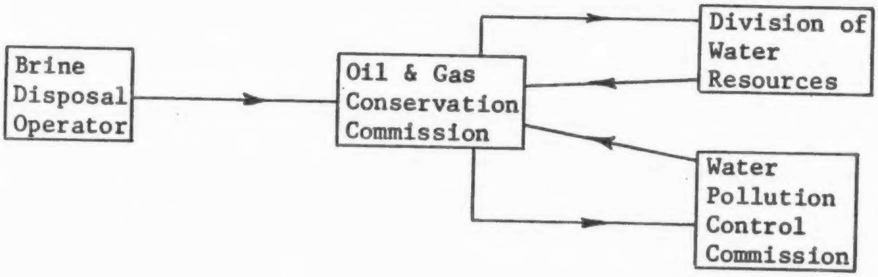

Brine Disposal Operator
Oil & Gas Conservation Commission
Division of Water Resources
Water Pollution Control Commission

Figure 15. Organizational Flow Charts for Dealing With Brine Disposal Applications in New Mexico and Colorado (after Reid and others, 1974).

various activities which might cause ground-water contamination during the drilling of oil and gas wells in Illinois.

It is obvious that because of split jurisdictions and the cooperative regulatory arrangements among State agencies described above, only highly skilled senior technical personnel should participate in these advisory decision-making groups. Moreover, the primary regulating agencies require a wide variety of technical personnel, including hydrologists, geologists, and sanitary engineers, to evaluate applications and to conduct or supervise field investigations during pre-construction, drilling, and post-construction periods. In many States, lack of regulations and statutes, of required personnel, and of coordination of effort and definition of responsibility among various agencies make it difficult under present circumstances to carry out an effective program of underground injection control.

D. Description of the Proposed Regulations.

1. Background Interpretations. It is clear from the language of the Safe Drinking Water Act and from the record of the Committee hearings, that the Congress intended for the States to exercise primary responsibility for protecting public health by controlling underground injection into drinking-water sources. Thus, the regulations developed by EPA have been designed to provide national minimum standards of protection and to blend as much as possible with existing State programs or programs acceptable to most States. The regulations, therefore, are modeled to some extent on previous EPA regulations, including those required for participation in the National Pollutant Discharge Elimination System, which was authorized under the Federal Water Pollution Control Act Amendments of 1972 mainly to protect and restore surface water quality. Many States now have permit programs approved pursuant to those earlier regulations, or in accordance with their own statutes. These existing programs form an effective and workable framework for joint Federal-State cooperation in implementing the regulations.

Aside from the general parallelism between the UIC regulations and others previously issued by EPA, certain modifications have been made in the regulations based on the special requirements for protecting underground drinking-water sources. Some of the major issues and interpretations of the provisions of the Act for which decisions had to be made in formulating the UIC regulations are summarized below:

a. Definition of Well Injection. The Act defines "underground injection" as "the subsurface emplacement of fluids by well injection" (Section 1421(d)(1)). However, "well injection" is not defined in the Act. EPA believes that "well injection" should be defined in the regulations because that term establishes the jurisdictional limits of the regulatory programs contemplated by the Act.

To begin with, the term "well injection" includes conventional waste disposal wells which are referred to specifically in the House Report and is discussed at length in the legislative history of the statute. Also, conventional brine disposal wells and recovery injection wells related to oil and gas production are specifically covered by the term "well injection," because the statute provides the EPA regulations may not "interfere with or impede" such well injection unless the requirements imposed are "essential to assure that underground sources of drinking water will not be endangered by such injection."

The term "well injection" also applies to certain other practices. Because the statute does not qualify "well injection" with the adjective "deep" or with the adjective "waste-disposal," EPA believes that those qualifications should not be imposed in the definition of "well injection" contained in these regulations. Accordingly, the definition of "well injection" proposed in Section 146.2(r) speaks in terms of the nature and function of the well rather than its depth or the material it injects. The definition covers subsurface emplacement of fluids through a bored, drilled, dug or driven well whenever the principal function of the well is to emplace fluids underground. This would include all "deep well" waste disposal, brine disposal by well, secondary and tertiary recovery wells, subsidence control wells, gas-storage wells, barrier wells, mining wells, and recharge wells. It would also include agricultural drainage wells and urban runoff wells.

b. Endangerment of Drinking-Water Sources. The House report on the Act (93-1185) states that the Congress ". . .seeks to protect not only currently-used sources of drinking water, but also potential drinking-water sources for the future. This may include water sources which presently exceed minimum intake water quality requirements or maximum contaminant levels or which are not presently accessible for use as a community drinking-water source. Thus, for example, the Congress expects the EPA's requlations at least to require States to provide protection for underground waters having less than 10,000 ppm dissolved solids...".

The basic approach of the regulations is to prohibit underground injection which may degrade water in an aquifer with 10,000 mg/l or less total dissolved solids, unless the injector can demonstrate that the degradation of the water will not endanger underground drinking-water sources. However, EPA believes that there should be some means dealing with individual aquifers which are not in fact potential sources of drinking water even though they have total dissolved-solids levels of less than 10,000 mg/l.

For example, an aquifer may be oil-producing even with a TDS level of less than 10,000 mg/l, and in such a case it may be wise to give the oil-producing capabilities of the aquifer precedence over its ability to provide drinking water. Also, the waters in some aquifers below the 10,000 mg/l level are never-the-less so contaminated that as a practical matter they are not potential drinking-water sources.

Because it would be a misallocation of resources to seek to protect as potential drinking-water sources aquifers which in fact will not be used by public-water systems, the regulations provide that a State program may designate one or more aquifers or parts of aquifers in the State which have a total dissolved solids content of less than 10,000 mg/l but which will not be protected because they are oil-producing, are severely contaminated, or located in such a way that use as drinking water is impracticable. As part of the State program, the designation of the aquifer would be subject to public notice and opportunity for hearing prior to submission to EPA.

c. Rules and Permits. The regulations require that the States create permitting programs for shallow and deep industrial and municipal disposal wells for subsidence control wells, salt-water intrusion control wells, solution-mining wells, recharge wells installed for aquifer augmentation, geothermal wells, gas-storage wells, and wells related to the production of oil and gas. A more flexible regulatory procedure is to be implemented with regard to drainage wells. These may be covered by rules or permits or a combination of the two at the option of the States. Rules based on individual State statutes, codes, ordnances, or administrative orders may be flexible or rigid and may, for example, prohibit certain types of injection which are permissible under the Federal regulations. However, in no instance, may any State rule allow underground injection which endangers a public drinking-water source.

2. Summary of Major Control Elements of the Underground Injection Regulations.

a. Three-Tier Control. The regulations contemplate three tiers of control based on individual requirements for three different categories of underground injection listed in Table 2. Effective December 16, 1977, or as of the time of the Administrator's approval of a State program, any underground injection which is not authorized by a State permit or rule is prohibited (146.10). The requirements for the three controlled categories of injection are described in detail in Subparts C, D, and E of the regulations and are summarized below:

(1) Requirements Applicable to Waste-Disposal Wells and Engineering Wells (Subpart C).
The types of underground injections controlled under this part of the regulations include industrial and municipal disposal wells, subsidence control wells, salt-water encroachment (barrier) wells, recharge wells for aquifer augmentation, solution-mining wells, geothermal, and gas-storage wells. States may take up to five years to issue permits for wells which were in operation prior to approval of the State UIC program. In the meantime,

these wells must be operated by rules of general applicability designed to prevent endangerment of underground drinking-water sources. Operators of existing wells and new wells must submit fairly detailed documentation on the location of the injection well and other wells and mines within a two-mile radius; geologic cross sections; direction of ground-water flow; head relations in affected aquifers; geological and physical characteristics of the injection interval and confining units; water-quality data; proposed injection procedures; and contingency plans to cope with well failures or shutdowns that endanger drinking-water sources.

Notice of applications for UIC permits must be circulated to interested parties including private individuals, other Federal, State and local government agencies, and interstate commissions who may provide written comments on the application or may request a public hearing. No permits will be issued unless the applicant can satisfactorily demonstrate that the proposed injection will not endanger underground drinking-water sources. Posting of bonds or other methods will be required to assure funds for remedying an improperly constructed or abandoned system that may cause contamination. Records of monitoring activities are to be retained for five years following abandonment of an injection well and monitoring data collected by the permittee shall be reported periodically to the State regulatory agency.

(2) Requirements Applicable to Injection Wells Related to Oil and Gas Production (Subpart D). Congress was clear in its intent not to authorize needless interference with oil or

gas production in the United States. Thus, the Act (Section 1421(b)) prohibits requirements that would interfere with or impede production of oil and natural gas or with disposal of by-products such as brine associated with such production, or underground injection for secondary or tertiary recovery of oil or natural gas, unless necessary to assure that underground drinking-water sources will not be endangered by such activities.

Consequently, although the UIC regulations do not put great constraints on energy production activities, they are specific enough to assure the safety of drinking-water sources. For example, injection through the annular space of wells is prohibited. Underground injection practices in operation at the time of approval of the State program may be regulated under existing State rules for five years while the State reviews the facilities to insure that endangerment of drinking-water sources does not exist. Where underground injection endangers a drinking-water source, such practice may be ordered to cease until proper action is taken to provide protection of drinking-water sources or the well will be plugged and abandoned. Existing wells will be evaluated to insure that strata containing water with 3,000 mg/l of dissolved solids or less are adequately protected with cemented surface casing and the long-string casing must be properly installed to prevent upward migration of contaminated fluids. In addition, completion and plugging reports for wells penetrating the injection zone within a one-half mile radius of injection wells will be reviewed.

The application forms for a UIC permit for new wells include detailed data on location, a variety of engineering, geologic, injection and reservoir fluid data, and depth of aquifers containing water with 3,000 mg/l and 10,000 mg/l of total dissolved solids. Public hearings on applications for permits shall be held upon request. Complete and accurate monitoring records shall be kept by the injector, and prescribed readings and tests shall be made at periodic intervals. Quarterly monitoring reports shall be supplied to State regulatory agencies.

(3) Requirements Applicable to Drainage Wells (Subpart E) Facilities covered by this subpart include urban runoff and agricultural drainage wells. These types of underground injection must be covered either by rule or by permits, at the option of the State. Minimum permit requirements include information regarding the location and design of the facility, the nature and volume of the fluid to be injected, and other information necessary to satisfy the State that the underground injection will not endanger underground drinking-water sources. Appropriate public notice must be given of any application for a permit and members of the public will be given an opportunity to comment on the application and proposed permit. Specified inspection, monitoring, recordkeeping, and reporting is required.

If a State elects to regulate this category of underground injection by rule, the State regulations at a minimum shall provide that the underground injection shall not endanger underground drinking-water sources, and the injector shall conduct periodic testing and maintain appropriate test records.

b. State Institutional Requirements. The regulations do not include specific requirements with regard to personnel or changes in existing State institutional frameworks. Aside from stipulating that certain procedures for permitting or submission of data must be adhered to, EPA recognizes that each State will have to fit the program into its present organizational structure and that, therefore, no uniform guidelines can be established that would be applicable to all States. Some States have a centralized agency responsible for all contamination matters and, in others, the responsibilities for permitting and controlling underground injection is dispersed among several State agencies.

c. Control by Federal Agencies. Although the Act delegates responsibility to the States for setting up permit and rule procedures to control underground injection, EPA has a primary responsibility for reviewing and approving proposed State programs. From time to time, EPA will issue guidelines and other information to help the States prepare their specific regulatory programs. The intent is that each State program will conform with certain minimum EPA requirements, but may be more restrictive. The goal of the proposed regulations is to establish a national minimal program of underground injection control so that all States will have similar minimum standards of public-health protection from underground injection.

If a particular State elects not to participate in the State underground injection control program because it (1) lacks the necessary facilities, (2) cannot conform with EPA time-table, or (3) is unable to enforce the regulations after entering the program, EPA must assume control of underground injection operations in such States. The intent is to uniformly meet the minimum requirements of the Act in all parts of the country. If a portion of a State's program meets the requirements of the Act and these regulations, that fact will be taken into account in the EPA's prescription and administration of a program for the State. EPA will administer only that portion of an underground injection control program for the State for which the State's program is not adequate.

d. Control on Federal Lands. Section 1447 of the Act indicates that each Federal agency with jurisdiction over a public-water system or injection system must comply with national primary drinking-water standards and State underground injection regulations. These provisions apply also to Federally owned or operated injection facilities on any lands owned or leased from the United States, except that for national security reasons, compliance with the underground injection regulations by some Federal agencies may be waived by the President. The State program need not apply to any underground injection on Indian land with respect to which the State's legal authority to enforce its program is in question.

II. ALTERNATIVES

A. Issues and Options. In the process of developing the regulations, several fundamental issues (Table 8) had to be addressed in order to develop a set of procedures that would best achieve the intent of the Act. The reasoning that was followed in evaluating each of these is discussed below.

1. Definition of Well Injection. The Act requires development of a program to protect underground sources of drinking water by prohibiting any underground injection that is not authorized by permit or rule. The term "underground injection" is further defined as "the subsurface emplacement of fluids by well injection" (P.L. 93-523, Section 1421(b)(1)). Missing, however, is a specific definition of well injection.

Various options exist for defining well injection. One is the so-called broad definition, which appears to be supported by the House Report (No. 93-1185) on the Safe Drinking Water Act:

> "The definition of 'underground injection' is intended to be broad enough to cover any contaminant which may be put below ground level and which flows or moves, whether the contaminant is in semi-solid, liquid, sludge or any other form or state."

The Committee placed only one restriction on this broad definition:

> "While the Committee does not intend this definition to apply to septic tanks or other individual residential waste disposal systems, it does intend that the definition apply to a multiple dwelling community, or regional system of injection of waste."

Table 8. - ISSUES AND ALTERNATIVES CONSIDERED IN THE DEVELOPMENT OF THE UIC REGULATIONS

	Issues	Alternatives			
1.	Definition of well injection	A 1/	B 2/	C 3/	D 4/
2.	Levels of drinking water quality protection	All waters regardless of TDS content	TDS content of 10,000 mg/l or less	No stipulation regarding TDS content	-
3.	Endangerment of drinking water sources	No degradation	Degradation up to drinking water standards	Degradation if no additional treatment needed	-
4.	Types of regulations	All permit	All rule	Combination of permits and rules	-
5.	Program Implementation				
	A. Listing of States	Simultaneous	Staggered	-	-
	B. Program staging	Immediate	Sequential	-	-
6.	Documentation by States	Detailed	Moderate	Detailed for permits, moderate for rules	-
7.	State personnel requirements	Specified for all personnel	Specified for professionals only	No specifications	-

---

1/ Conventional deep industrial and municipal injection wells and injection wells related to oil and gas production.

2/ Column A wells and all other wells which function principally to emplace fluids underground such as urban runoff, agricultural drainage and engineering wells (see Table 2).

3/ Column B wells, multi-dwelling septic systems, pits, ponds, and lagoons designed to function principally to emplace fluids underground.

4/ Column B wells and septic systems, and all pits, ponds, and lagoons used to dispose of fluids.

It follows from this interpretation that the term "well injection" embraces underground injection into any actual well, artificial excavation, or natural opening in the land surface that discharges into underlying permeable beds and thereby, could serve as a possible source of ground-water contamination. Table 9 lists categories of underground injection included in the broad definition of well injection, together with estimates of the numbers of such injection facilities.

An important advantage of adopting the broad definition is that it provides for regulation of a wide spectrum of possible sources of ground-water contamination. This would provide the greatest level of protection against contamination of underground drinking-water sources. This is also compatible with the basic intent of the Act, to protect underground sources of drinking water and is an approach favored by some States. It should be noted, however, that even the broad definition does not encompass all possible sources of ground-water contamination. For example, activities such as surface spills, overpumping of wells, and application of fertilizers and pesticides at the land surface all can contribute to contamination but are not included in well injection as defined in these regulations.

Several major problems arise as a result of including a wide range of facilities and activities in the broad definition of well injection. These problems are of sufficient magnitude to cause rejection of the broad definition. First, it was not con-

Table 9.- ESTIMATED NUMBER AND CATEGORIES OF UNDERGROUND INJECTION FACILITIES INCLUDED IN THE BROAD DEFINITION.

Category	Number
I. Waste-Disposal and Engineering Wells	
Conventional industrial wells	360
Conventional municipal wells	30
Subsidence control wells	500
Barrier wells	200
Recharge Wells (for aquifer augmentation)	100
Solution mining wells	500
	1,690
II. Injection Wells Related to Oil and Gas Production	
Brine disposal wells	10,000
Secondary recovery wells	60,000
Pits	1,000
	71,000
III. Other Underground Injections	
Industrial shallow wells	1,000
Industrial pits, ponds, and basins	50,000
Industrial septic systems	25,000
Municipal shallow wells	1,000
Municipal pits, ponds, and basins (mainly sewage effluent and storm water)	25,000
Septic systems (multi-family residences, restaurants, motels, etc.)	1,500,000
Drainage wells (agricultural, urban runoff, and sewage)	50,000
Gas-storage wells	14,500
Geothermal wells	10
	1,666,510

sidered reasonable by many to group pits, ponds, and basins with wells as underground injection devices, on the basis of the language of the Safe Drinking Water Act or on the basis of a technical evaluation of the definition of well injection. Second, it was anticipated that there would be a great number of legal challenges and EPA would be accused of over-regulating. Third, because of the large number of installations (possibly numbering in the millions) and the costs of permits and hearings, and construction and monitoring requirements, the financial impact and work load were believed to be prohibitive for EPA, the State governments, and the injectors.

A second option for defining well injection is very narrow. It would restrict the meaning of the term to conventional deep municipal and industrial disposal wells that discharge into strata containing fluids having a total dissolved solids content of more than 10,000 mg/l, which are referred to specifically in the House Report and are discussed at length in the legislative history of the statute. Also included are brine disposal wells and secondary recovery injection wells related to oil and gas production which are specifically covered by the term "well injection", because the statute provides that the EPA regulations may not "interfere with or impede" such well injection unless the requirements imposed are "essential to assure that underground sources of drinking water will not be endangered by such injection." The total number of underground injection facilities included in the narrow definition is estimated to be about 390 conventional wells and about 70,000 brine disposal and secondary recovery wells (see Table 2).

The principal advantage of adopting the narrow definition would be its relative ease of implementation. Because the number of wells to be controlled would be relatively small, public acceptance of the program should be forthcoming and, in addition, the administrative task would be relatively easy for the States to handle. In actuality, some 39 States already have some controls to regulate or prohibit these wells.

The overwhelming disadvantage of a regulatory program restricted to the very narrow definition is that it would contribute little additional to the existing controls that protect ground-water quality. From regional surveys that have been made of ground-water contamination (Fuhriman and Barton, 1971; Scalf and others, 1973; Miller and others, 1974; and Van der Leeden and others, 1975), it is known that conventional injection wells are only minor contributors to contamination, and that regulation of only this limited type of underground injection would ignore the need to control many more significant sources of contamination. Furthermore, the will of Congress as expressed in the Act, which clearly is to protect underground sources of drinking water, would not be fully carried out.

A third option is a less narrow definition of "well injection" which encompasses all drilled, bored, dug, or driven wells which function principally to emplace fluids underground. This definition includes all waste-disposal wells, injection wells related to oil and gas production, urban runoff drainage wells, agricultural drainage wells, gas-storage wells, geothermal wells, and engineering wells. The advantages of this definition are: (1) it provides an intermediate level of protection of underground drinking-water sources in contrast to the very narrow definition, (2) the program would be sufficiently moderate to encourage States without large program capabilities to seek primacy, and (3) costs of compliance would be moderate. On the other hand, under this definition, the UIC program would not include hundreds of thousands of facilities such as pits, ponds, and lagoons which also are designed to receive and emplace waste fluids underground. Also, some States favor a still broader definition of well injection.

A fourth option for defining well injection is somewhat broader than the third option in that it includes not only all the wells noted in option three but also multiple-dwelling septic systems and pits, ponds, and lagoons whose principal function is to emplace fluids underground. The principal advantages of this interpretation of well injection are: (1) it would bring under control more practices that pose a hazard to underground drinking water sources, (2) it would bolster existing State programs regulating these facilities, and (3) a number of States favor an approach to control that is at least this broad in coverage. The principal disadvantages of this interpretation are: (1) the increased costs and workload would reduce the number of States seeking primacy, (2) EPA would be subject to criticism for attempting to control practices not intended by Congress, (3) the broader definition would be challenged legally by many injectors,

(4) it may be difficult in many cases to establish whether a pit, pond, or lagoon functions like an injection well, without costly and time-consuming studies; moreover the number of such facilities is not known precisely,and (5) the cost of compliance would probably be increased by billions of dollars.

It follows from the foregoing that all definitions of underground injection pose some problems. The all-important aspect of protecting public health against threats stemming from contamination of ground-water supplies requires that some practical and feasible definition and position be adopted. Thus, the regulations (Section 146.2r) define subsurface emplacement of fluids by well injection as subsurface emplacement through a bored, drilled, driven, or dug well (where the depth is greater than the largest surface dimension), whenever a principal function of the well is the subsurface emplacement of fluids.

2. Levels of Water-Quality Protection. This important issue, raised by the language of the Safe Drinking Water Act and the accompanying House Report (No. 93-1185), pertains to the kinds of underground waters that are intended to be protected and the extent of this protection. The Act specifies that regulations promulgated under it shall contain minimum requirements for

effective programs to prevent underground injection that endangers drinking-water sources. It is further stated that:

> "Underground injection endangers drinking water if such injection may result in the presence in underground water, which supplies or can reasonably be expected to supply any public water system, of any contaminant, and if the presence of such contaminant may result in such systems not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons."

The House Report contains a further interpretation of the intent of the Congress. In that report (p. 32), it is stated that the Congress seeks to protect not only currently used sources of drinking water, but also potential drinking-water sources for the future. Thus, for example, it is expected that the UIC regulations should at least require States to provide protection for subsurface waters having less than 10,000 mg/l of TDS (total dissolved solids), as is currently the practice in Illinois and Texas.

As explained in Section I of this report, the natural quality of ground water differs from place to place, depending on geologic and other factors. Total dissolved-solids content is commonly used to characterize the salinity of ground water. The U. S. Geological Survey (Hem, 1970) classifies water according to TDS content as follows: Less than 1,000 mg/l, fresh; 1,000 to 3,000 mg/l, slightly saline; 3,000 to 10,000 moderately saline; 10,000 to 35,000, very saline; and more than 35,000 mg/l, briny. Only fresh waters are recommended for drinking purposes, although slightly to moderately saline water is used by more than 100 public-supply systems in Illinois where water of better quality is not available.

Water having a TDS content of from 3,000 to 10,000 mg/l is less salty than seawater (TDS, 35,000 mg/l), and is more amenable to desalination than saltier waters. For example, in a study performed in Illinois (Illinois Water Survey, 1973), it was found that the ion-exchange and electrodialysis processes of desalination are particularly sensitive to the TDS content of the feed water. The capital cost of a reverse-osmosis plant was estimated to double with an increase in feed-water salinity of from 2,000 mg/l to 4,000 mg/l TDS, and electrodialysis was found to be uneconomic for feed water with a TDS content greater than 10,000 mg/l.

In most parts of the United States, the ground water first encountered when drilling a well is fresh or relatively fresh, and in many localities, this condition persists to depths of many hundreds of feet. Generally, the TDS content increases at progressively greater depths.

The most restrictive option would be to control any and all underground injection into all waters, regardless of TDS content and regardless of present or future uses of the water. This option was rejected because it goes beyond the intent of the Congress to protect only the quality of present or potential drinking-water sources.

The most non-restrictive approach in establishing the level of protection of water quality would be to allow any and all types of injection into aquifers with no regard to the risk of endangerment of drinking-water sources (as discussed in the next section). This option would have the least impact on present and future injectors but would be inconsistent with the intent of the Congress, as expressed in the Act, to protect drinking-water sources. The non-restrictive approach would result in increasing degradation of ground water in future years as a result of largely uncontrolled underground injection practices.

With the exception of most municipal and industrial disposal wells and oilfield brine wells, nearly all other types of underground injection systems listed in Table 2 presently inject into fresh or moderately saline ground water having a TDS content of less than 10,000 mg/l. Obviously, the highest level of protection of public health would be achieved by controlling injection into such water, and this is the option that finally was selected for the regulations.

However, EPA believes that there should be some means of dealing with individual aquifers which are not in fact potential sources of drinking water even though they have total dissolved solids levels of less than 10,000 mg/l. For example, an aquifer may be oil-producing even with a TDS level of less than 10,000 mg/l, and in such a case it may be wise to give the oil-producing qualities of the aquifer precedence over its ability to provide drinking water. Also, some aquifers below the 10,000 mg/l level are never-the-less so contaminated that as a practical matter they are not potential drinking-water sources.

Because it would be a misallocation of resources to seek to protect as potential drinking water sources aquifers which in fact will not be used by public-water systems, the regulations provide that a State program may designate one or more aquifers or parts of aquifers in the State which have a total dissolved solids level below 10,000 mg/l but which will not be protected because they are oil-producing, are severly contaminated or are located in such a way that current or future use as drinking water is impracticable. As part of the State program, the designation would be subject to public notice and opportunity for hearing prior to submission to EPA.

By protecting water quality up to the indicated TDS, virtually all other users, including industrial, commercial, and agricultural, will benefit from maintenance of that level of ground-water quality protection. Moreover, this flexibility will provide adequate protection for usable sources and at the same time will permit the States to take local conditions into account.

This level of protection provided by the regulations complies with the objective of the Act to develop regulations for State UIC programs which will not establish unnecessary and unreasonable obstacles to approval of State programs. It also should not impose a burden upon injectors that is overly restrictive, yet is designed to focus attention on ground-water sources used for public supply.

3. Endangerment of Drinking-Water Sources. A key goal of the Act is to prevent the endangerment of drinking-water sources, as expressed by the specific language of the Act. Further, the House Report (No. 93-1185) provides some guidance by indicating that any underground source with a TDS content of 10,000 mg/l or less should be protected. This language opens many alternative interpretations. Three alternatives were considered as follows:

(a) Sources of underground water are endangered by underground injection whenever they are degraded to any extent. This nondegradation approach would insure the preservation of the natural quality of ground water for all future uses, but would make it impossible to inject any fluids except fresh water of a certain quality into any aquifer containing water with a TDS content less than 10,000 mg/l.

(b) Sources of underground water are endangered by well injection whenever they are degraded below national primary drinking-water standards. This alternative would allow some reduction in quality, but not to an extent where the potability of the ground water would be affected. One problem with this option is that many contaminants that are not now included in the drinking water standards may be added in future years; therefore, underground injection controls would have to be designed now to protect against unknown contaminants in the future.

(c) Sources of underground water are endangered by underground injection whenever it becomes apparent that a public-water system desiring to use the source at any time would have to resort to more extensive treatment of the water than would have been necessary before the contamination. This option permits some flexibility for underground injection into shallow fresh-water aquifers because it relates not to the quality of ground water itself but rather to the degree of additional treatment that would be required.

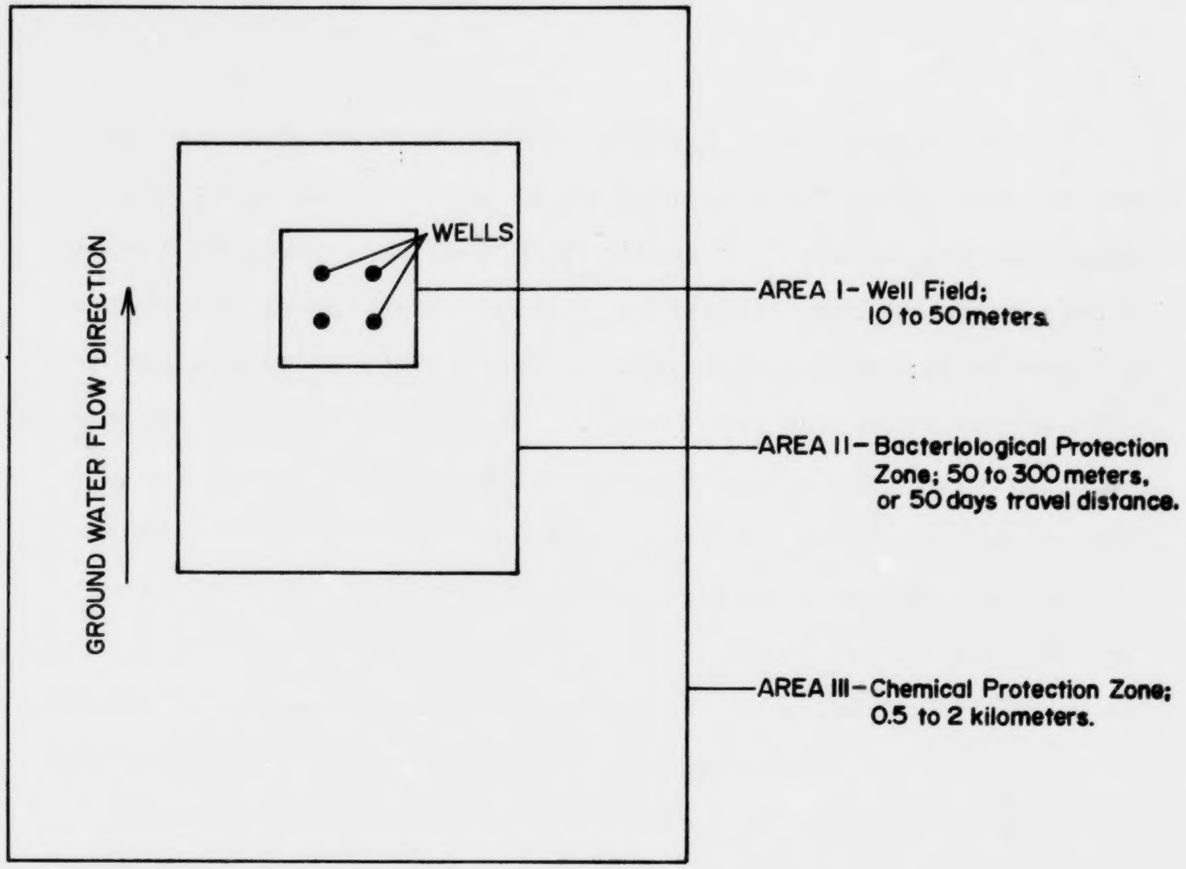
Of the foregoing three alternatives, alternative (c) has been adopted in the regulations because it is the least restrictive upon underground injection practices and because it does not impose a burden of additional treatment on future public-water systems.

It should be noted that endangerment of underground drinking-water sources is related not only to the type and volume of the injected fluid but also to the distance between an injection site and a water-supply well. As described in Section I, the concentrations of contaminants in ground water are attenuated by adsorption, decay, and dilution during their passage through underground formations. Thus, with sufficient separation between injection sites and supply well sites, endangerment can be minimized.

The States may wish to evaluate the concept of zonal protection of public-water supply installations. The use of zoning originated in Germany (Todd, 1973) and has been used elsewhere in Europe (Cole, 1974). Figure 16 illustrates one method of providing protective zones within which certain potentially deleterious injection practices are prohibited. The actual configuration of the zones in any particular place would be based on the local hydrogeologic situation.

Another variation of the same concept would be to establish buffer zones around underground injection sites. The boundary of the outermost zone would coincide with the property boundary of the injector. Ground water under the injector's property could be degraded as long as this practice did not endanger a drinking-water source on any adjacent property.

4. Types of Regulations. Control of underground injection can be achieved by the following regulatory methods: (1) an "all-permit" program, (2) an "all-rule" program, or (3) a combination of these. Each method has distinct advantages and disadvantages.


WELLS
GROUND WATER FLOW DIRECTION
AREA I – Well Field; 10 to 50 meters.
AREA II – Bacteriological Protection Zone; 50 to 300 meters, or 50 days travel distance.
AREA III – Chemical Protection Zone; 0.5 to 2 kilometers.

EXPLANATION

Area I is the actual well field property. This area is generally owned by the water-supply company, is grassed and fenced, and trespassing is prohibited. It extends about 10 to 50 meters from the wells in all directions.

Area II is the bacteriological protection zone. Here activities which might adversely affect the bacterial quality of water are prohibited. These include, among others, landfills, mining, quarries, parking lots, extensive use of fertilizers, construction, transport of dangerous liquids, plus exclusions for Area III. The zone should extend the distance that ground-water would travel (on the average) in 50 days, or a minimum of 50 meters.

Area III is the chemical protection zone. In this relatively large region prohibitions include recharge of wastewater, oil and gas pipelines, atomic energy plants, refineries, new cemeteries, airports, and military bases. The zone extends from 0.5 to more than 2 kilometers.

Figure 16. Sketch of Protective Zones for Ground-Water Supplies (Alluvial aquifers are assumed, and zones are not to scale).

a. "All-Permit" Program. Under this program, all existing and new underground systems would be regulated under a highly organized and closely controlled permit system, designed largely according to EPA specifications, but administered by the States. The principal advantage would be a very strong uniform control of underground injection practices throughout the country, which would help maintain ground-water quality at acceptable levels and thereby benefit public health. The detailed information required in the application procedures, public hearings, and periodic reviews would provide abundant data for making sound decisions in regard to granting and renewing permits, and would facilitate the taking of remedial action in the event of the development of hazardous conditions to health or water quality during the operation of the injection system. Moreover, many injection systems already operate under some type of State permitting arrangement, which would constitute a base on which to build a technically sounder permit system.

The principal disadvantage of an "all-permit" program would be the inability of many State regulatory agencies to cope with the vast numbers of applications for permits that would be required under the broad definition of underground injection. The financial and staffing impacts would be severe enough in many States to seriously interfere with the present load of regulatory environmental responsibilities, and thereby could result in further degradation not only of the water environment but also of other aspects of the environment related to public health. Permitting procedures calling for public notices and hearings could seriously extend the time required for approval of permits, which would result in additional costs and delays in organizing the permit system.

b. "All-Rule" Program. Under this program, all types of underground injection would be covered by individual State rules. State rules would include directives on construction and operational procedures that do not endanger underground drinking-water sources.

The advantage of an "all-rule" program is the wide administrative freedom and flexibility given to the States, which would enable them to initiate the control system with a minimum of procedural delay. This would bring most underground injection operations under some type of control and surveillance within a short period after the start of the program. Much of the data collection and compilation could be automated, which would call for fewer experienced professional personnel who are now in short supply. Rapid start up of the system would benefit water-quality control and public health.

Conceivably, the States could have extremely loose rules giving blanket authorization for specified classifications of underground injection without the requirement of public hearings, notices, or recording of detailed technical information. On the other hand, rules could be more restrictive than the permit program described above, or even specify prohibition of certain underground injection practices.

The disadvantage of an "all-rule" program is that it does not set meaningful minimal requirements for the States and of necessity results in a lack of uniformity of control from one State to another. It also could create water-quality conflicts between States who share aquifers that cross State boundaries. Furthermore, an "all-rule" program could interfere with or conflict with State and Federal requirements under existing permitting procedures such as NPDES.

c. Combination "Permits and Rules" Program. Under this program, some underground injection practices would be authorized under permits and others would be authorized under rules. EPA would issue a list of recommended injection practices to be placed under permit and would prepare guidelines for State operated permit systems that would be uniform throughout the country. The remaining types of underground injection practices would be controlled by either rules or permits at the discretion of the States.

The principal advantage of this approach is that it is consistent with present policies in most States, and would be rather easy to implement. Also, it does not restrict the States from adopting more protective rules than they have presently, or to change from rules to permits if they believe that this is necessary to improve protection of drinking-water sources and public health. In addition, many types of underground injection are already under State rule or permit, and may only require tightening of selected requirements such as providing more technical data, reports, and monitoring programs.

The disadvantages of the combination program are a limited uniformity among the States and a reduced level of control compared with an "all-permit" program. However, the greater feasibility of implementation from a time and manageability viewpoint and the large measure of control afforded by the combination program indicate that it should provide the greatest protection to ground-water quality and public health on a national scale.

5. Program Implementation. The underground injection control program could be implemented in several ways, as discussed below:

a. Listing of States. Section 1421 (b)(1)(A) of the Act specifies that minimum State underground injection control programs must prohibit, effective December 16, 1977, underground injection that is not authorized by permit or by rule. In addition to the above requirements, Section 1422 (a) directs the Administrator to publish, within 180 days after passage of the Act, a list of the States for which in his judgment an underground injection control program is necessary. The Act also provides for amendment of the list of States from time to time, and the House Committee Report (page 32) suggests that all fifty States should be listed; but the Act provides for judgment on the part of the Administrator in this regard. The listed States then have 270 days after the date of promulgation of State underground injection control program regulations to apply for control authority. If a State does not apply or if EPA determines its program to be inadequate, EPA must then institute an underground injection control program in that State. An unlisted State does not need to meet any requirements of the underground injection control program section of the Safe Drinking Water Act. The provision for State listing provides a means of scheduling the implementation of the program. Two options are available for listing States. EPA could list all States immediately, or a few States could be listed immediately with others being added from time to time.

The principal benefits of listing all States initially are: (1) complete uniformity in treatment of the State and (2) the earliest possible implementation of the UIC program. A possible problem in listing all States initially is, if a significant number should not apply for primacy, EPA would have to establish programs for these States. This possibility would be remote if a maximum effort were made to keep the regulations flexible enough to match State needs and capabilities.

Another alternative would be to list a few selected States the first year and to add additional States in subsequent years until all 50 were listed. This procedure would achieve the intent of Congress that all States should have programs and it would also allow EPA to concentrate its manpower on a few States at a time, rather than attempting to deal with all 50 States simultaneously. The greatest disadvantage of such a phased approach would be unequal emphasis on State programs of the States and the delay that would result in promulgation of the regulations on a nation-wide basis. Further, it is required in Section 1421 (b)(1) of the Act that in order for a State program to be approved, any underground injection which is not authorized by permit or rule by December 16, 1977, must be prohibited.

b. Program Staging. One means of staging the implementing of the UIC program would be to specify which of the regulatory requirements would be adopted immediately and which would be introduced later. The requirements for State certification of the UIC program which are discussed in Section 1421 (b) (1) of the Act are rather loosely defined, and fall into two main classes: (1) permitting, or rule-making, and (2) all other requirements (inspection, monitoring, recordkeeping, and reporting requirements) which are not elaborated.

The less explicitly defined requirements of the Act allow for a greater amount of flexibility in implementation. For the first few years of the program, for example, States could be required to inspect only the major underground injection practices. When the workload leveled off, a gradual more intensive inspection program could be started for other underground injection practices.

This same approach also could be applied to monitoring and inspection as shown below:

MONITORING

Within the first year of certification	-	Require self-monitoring reports monthly (or quarterly) from all permittees.

Within 3 years - Initiate a program of test wells for all existing underground injection practices that are potential problems.

Within 5 years - Require test wells for all new underground injection projects that have a potential for ground-water contamination.

An advantage of this sequential approach is that it would allow the State to spread its resources over several years. A disadvantage would be the problem it would create for EPA in administering a large number of widely varying schedules and the lack of uniformity that would exist among the State programs at any given time. More important , however, is the fact that many potentially dangerous underground injection facilities would continue uncontrolled injection for several years before the State began any type of control program.

The second alternative is to make all requirements of the Act mandatory from the beginning of the State's program. In this case, EPA would develop minimum requirements on all aspects of permitting, inspection, monitoring, recordkeeping, and reporting. All of these requirements would be begun immediately. An advantage of this approach is that the requirements in all States would be uniform and consistent. The major disadvantage is that due to the nonhomogeneity of hydrologic and geologic conditions in the United States, it would be difficult to develop such requirements in a manner which would allow maximum control but still allow the State to consider its differences.

The approach chosen reflects a combination of these two approaches to implementation. Specific requirements for permitting, monitoring, inspection, and recordkeeping are made for most underground injection practices. For up to five years the States may regulate existing underground injections by rules of general applicability designed not to endanger drinking-water sources. During this five-year period, the States will review all existing injections to ensure underground drinking-water sources are not endangered. Permits will be issued to all existing wells which meet this requirement. New wells will be required to meet all permitting, monitoring, inspection and recordkeeping requirements at the outset.

On all other practices, the State is given the flexibility of controlling these practices in a manner which best fits the situation in the State. The only stipulations are that nothing should be done which endangers drinking-water sources, and the public should be involved in the decision-making process. It is very likely that the first control placed on existing and new underground injection facilities will be a self-monitoring report which would be delivered to the State within one year. Using this information, the State would plan how all underground injections would be controlled to prevent endangerment of drinking-water sources.

The major disadvantages of this approach are the non-uniformity of State programs and the difficulties which

EPA would encounter in monitoring the many different programs. The major advantages, however, are the fact that all underground injections would be put under some control immediately and the State would have the flexibility of developing control programs which would be unique to their geologic and hydrologic conditions.

(6) Documentation by States. From an overall viewpoint, the documentation and reporting required in connection with the regulations can be classified as: (a) submissions by the States to EPA, (b) applications to the States by injectors, and (c) routine periodic reports on monitoring to be provided to the States by injectors.

In making a decision on how comprehensive the documentation should be, careful consideration was given to the concern expressed by Congress with respect to controlling underground injection and to the need for providing a firm base of technical information so that the long-term benefits to drinking-water sources could be properly defined. Obviously, the greatest level of control would be achieved by requiring permits and an intensive documentation for all underground injection practices, but as noted under Section II 4(a) of this report, this would be impractical.

If the regulations had required permits for each and every type of underground injection, there would have been a substantial amount of communication and interaction between State and Federal officials regarding such matters as the filing of permit applications, the nature and amount of injected fluids, subsurface behavior of the fluids, public notices of applications, public hearings, and provisions for inspection of and copying of permit application data. These activities would call for a significant amount of administrative and technical documentation at the application stage. Moreover, permitting procedures would have to provide for subsequent detailed monitoring procedures and maintenance of records of all monitoring activities, including sampling dates, analytical results and methods, and retention of records for five years after cessation of injection. Reporting of monitoring results, not less than once per year on specific forms, also would be required.

Such detailed recordkeeping would of course result in collection of more accurate and abundant monitoring data and, therefore, would afford better surveillance and protection of ground-water quality. A major disadvantage would be the substantial amount of personnel, time, equipment, and storage facilities that would have to be allocated to collect and to evaluate these voluminous records. This would heavily impact both State and EPA facilities, personnel, and budgets.

Under a "rules-only" system, the States would set up their own arrangements for documenting and monitoring, within a broad range of guidelines prescribed by EPA. The States would be responsible for and would have more flexibility in selecting adequate monitoring procedures, and the amount of paperwork involved could be adjusted to fit the States' needs. The main disadvantage of the rules-only approach would be a lack of uniformity in procedures in the compilation of basic information, and in the reporting of findings, which would result in a lower level of protection of drinking-water sources.

Under the regulations, a State applying to the Administrator for approval of its underground injection control program shall describe how its program conforms to the regulatory requirements, furnish the text of the State's statutory authority, and document the anticipated State procedures for enforcement, inspection, monitoring, and recordkeeping. When EPA approves the plan, it shall remain in effect thereafter, subject to periodic reviews by EPA to insure compliance.

States participating in the program shall maintain records on permits, monitoring, and enforcement actions. In addition, the State will submit an annual report to EPA summarizing violations and any enforcement actions to be taken by the State and a summary inventory of underground injection facilities.

All existing and new underground injection practices covered under Subpart C of the Regulations must furnish information relating to the physical environment at the injection site, locations of injection wells and nearby water wells, groundwater conditions, geologic structures, chemistry of fluids, injection procedures, and other pertinent features. The injector also must submit a report thoroughly evaluating all alternative disposal schemes to justify that injection is the most acceptable environmental alternative. The State will notify appropriate governmental agencies of the permit application and shall solicit their views and recommendations. A provision is included to allow for public hearings to be requested by either the applicant or any interested agency or person. The State program shall specify that the injector maintain proper records of his injection practice and related monitoring. The injector also must submit a report to the State at least once per quarter.

For existing underground injections under Subpart D of the regulations, the State is required to review such underground injections during the first 5 years to ensure these practices do not endanger drinking-water sources. No detailed procedures for record-keeping and documentation are specified during that time. When permits are given to existing wells which do not endanger drinking-water sources the monitoring and record-keeping requirements outlined previously must be met. The permit applications required for new underground injection in the oil and gas industry must contain all of the information referred to previously, plus information on several other technical matters. The injector will keep records of his injection operation and monitoring.

Under Subpart E of the regulations which applies to agricultural and urban runoff drainage wells, if the State chooses to regulate these wells by permit, the permit requirements must include information on location and design of the facility, nature and volume of the injected fluid and other information the State may require to determine whether the underground injection endangers drinking-water sources. The permits issued will be conditioned on inspection, monitoring, record-keeping and reporting requirements.

If a State elects to regulate these types of wells by rule, the Director is to be notified of each such injection well and be provided with such information as he requires. Furthermore, the injector shall conduct periodic testing and maintain test records where specified by the Director.

The decision to use a combined permit-and-rule approach to implement the underground injection control regulations represents a practicable compromise in terms of the need for record-keeping and documentation. A "permit-only" system would have imposed too heavy an administrative burden on the States, and a "rules-only" system, although minimizing the administrative burden, would not have provided an adequate level of protection of drinking-water sources. It is believed that the extra work required of the States in recording and filing information will not be excessive and will be in line with the normal requirements of any similar regulatory program.

7. State Personnel Requirements. During the drafting of the regulations, the options of either specifying minimal levels of expertise for the State personnel who would be administering

the underground injection control program or of not including such provisions were considered. Requiring the State agencies to be staffed with highly skilled and experienced personnel would of course insure the highest level of compliance with and proper enforcement of the Act and, thereby, provide maximum protection of underground drinking-water sources. The principal disadvantage of this approach is that there is presently a scarcity of experienced personnel in the ground-water field, and the impact on State budgets of the high cost of salaries to maintain such personnel would be appreciable. Also, the staffing problem would vary from State to State, depending on local economic conditions, other job opportunities, and the availability of relevant university training programs.

In view of these problems and recognizing that the States are in a better position to define what kinds of personnel are available locally or could be made available to implement the underground injection control program, it was decided to omit any specifications with regard to personnel qualifications. The States have shown themselves to be fully capable in the past of implementing new regulations, and EPA believes that with proper coordination between the States and the regional offices, any deficiencies in this connection will be overcome.

The States should be able to satisfy the needs of the program by using a minimum number of high-level supervisory professionals, supported by subprofessionals and technicians having not less than some prescribed combination of academic and work experience. The scarcity of more experienced personnel might be partially compensated for by the use of substantial but costly automation of collection and processing of monitoring data. Also, the occasional lack of high-level input in some important decision-making situations could be overcome by temporary use of experienced advisors to assist State officials.

B. Procedural Alternatives. In developing the basic concepts and the prescribed administrative procedures for the regulations, careful consideration was given to a number of alternatives, ranging from little or no intervention in State programs to tight Federal control of all aspects of the program. In this analysis, the issues and alternatives discussed previously in Section II-A were evaluated and the probable impacts of all the alternatives on the States, the operators of underground injection facilities, the quality of drinking-water supplies, and public health were assessed. The final regulations, as published, reflect some trade-offs and compromises, with the ultimate purpose of achieving maximum protection of the underground sources of drinking water with the lowest possible level of adverse impacts to the States and injectors.

The following sections review the analytical procedures followed in arriving at the final decision. The first section deals briefly with the unacceptable option of taking no action at all. The second and third sections describe the reasoning process followed in rejecting the extremes of very rigid Federal controls and loose non-restrictive controls. The fourth section assesses the regulatory procedures that have been adopted.

1. Take No Action. This alternative means that EPA takes no action whatsoever with regard to underground injection control, and leaves all responsibility for initiating programs in the hands of the States. In effect, such a policy would represent no departure from the present situation, in which each State is largely free to control underground injection to whatever degree it deems necessary, except for injection related to such programs as NPDES.

The no-action alternative is precluded by the Safe Drinking Water Act, which specifically requires (Section 1421) that EPA shall promulgate regulations for State underground injection control programs and shall prohibit, effective three years after the date of enactment of the Act, any underground injection which is not authorized by a permit (or a rule) issued by the State. The Act contains additional requirements, as discussed under Section I of this report, which are quite specific with regard to EPA's role and which further support the position that a policy of no action whatsoever is unacceptable.

2. Promulgate Restrictive Federal Regulations. Under this alternative, EPA would issue very tight regulations in which underground injection is defined broadly to include all types of drilled, cased, and cemented injection wells and all openings or excavations that place contaminants into the ground water. The regulations would require permits for every type of underground injection facility, and these permits would be applicable

to all fifty States within the three-year requirement specified in the Act (Section 1421). In addition, injection would be allowed only into aquifers in which the ground water contained more than 10,000 mg/l of total dissolved solids. The States would be required to maintain detailed records with regard to inspection, monitoring, and reporting of other kinds of information on all injection sites and facilities. Finally, the regulations would specify the minimum levels of expertise needed by the staffs of State agencies before the State programs would be acceptable to EPA.

a. Beneficial Impacts.

(1) A program of this kind would assure uniformity of procedures, surveillance, and enforcement throughout the fifty States, and would represent a high degree of control over all underground injection facilities. In contrast to the present situation, in which each State is essentially free to deal with injection as it sees fit, a national standard would be applied so that all injectors would be treated on an equal basis.

(2) EPA would be able to oversee and control underground injection to the fullest extent.

(3) Underground drinking-water sources would be protected to a maximum degree, thereby reducing threats to public health and overcoming many of the problems faced by public water-supply systems in developing water that meets the national standards for drinking-water quality.

b. Adverse Impacts.

(1) Tight Federal control would be inconsistent with

EPA's policy of delegating the maximum possible degree of authority to the States. The basic intent of the Act is for EPA to provide guidance and to establish a broad regulatory mechanism, not to dictate precisely what is to be done by each State, because the States have a better understanding of local environments, local problems, and the social and economic implications of making changes in underground injection practices.

(2) From a technical viewpoint, it would not be feasible to write a detailed set of regulations to fit all of the widely different ground-water environments and patterns of ground-water use throughout the country. For example, all ground water in some States contains less than 10,000 mg/l of total dissolved solids, whereas in other States ground water may contain more than 200,000 mg/l of total dissolved solids.

(3) The burden of inventorying, documenting, issuing permits for, and monitoring every injection facility would be too great for most States, and would call for large budgetary increases to organize and staff new departments to handle the work load. If State funds were not available, Federal financial support would be necessary.

(4) Injectors would be subjected to severe new constraints on their operations, and in many cases would have to turn to costly alternatives or if alternatives were not available, to cease operation.

c. Action Taken.

This alternative was rejected because of its extremely high cost to the States and the injectors and because it deprives the States of flexibility in dealing with different ground-water environments.

3. Promulgate Non-Restrictive Federal Regulations. Under this alternative, EPA issues very loose regulations in which underground injection is defined in a narrow sense to mean only conventional industrial and municipal disposal wells, of which there are about 390 in the United States. This injection practice would be covered by rules specified by the individual States. The program would be implemented over several years. There would be no specifications with regard to the quality of the ground-water into which fluids could be injected. There would be no stipulations by EPA with regard to data requirements in the States, and similarly, EPA would set no specifications with regard to competence of personnel or the number of persons needed to make the program effective on the State level.

a. Beneficial Impacts.

(1) This approach would have a minimal impact on State budgets and institutions, because it would not represent more than a minor departure from present State practices. About 39 States already have some permitting programs for conventional disposal wells, and only in the remaining States would new rules have to be issued to cover these facilities. Finally, P.L. 92-500 already specifies a permitting program for this type of well.

(2) The impact on the injectors would be minimal because very little change of injection operations would be required.

b. Adverse Impacts.

(1) This approach would fall far short of achieving national uniformity on control of underground injection. The existing wide disparities in State regulatory programs would remain, which would mean that EPA would be unable to carry out the elements of the program described in the Act.

(2) Little or nothing would have been accomplished with regard to protecting the quality of ground water delivered by public water-supply systems, so that the level of the threat to public health would not be reduced in any significant way. The problems faced by water-supply systems in furnishing good water would remain as serious as before or even become more serious.

c. Action Taken.

This alternative was rejected because nonuniformity of controls and lack of adequate controls would not improve the present level of public-health protection from underground injection as required by Congress.

4. Promulgate Intermediate Federal Regulations. In the regulatory approach that was finally proposed, certain compromises were made to minimize adverse impacts on States and injectors, while at the same time developing the requirements for State programs stipulated in the Act. The defin-

ition of underground injection adopted encompasses all drilled, bored, driven or dug wells which function principally to emplace fluids underground. This would include waste-disposal wells, injection wells associated with oil and gas production, and urban run-off, agricultural drainage, and engineering wells. A combination of permits and rules is stipulated, permits being specified only for conventional injection wells, injection wells related to oil and gas production, engineering wells, and a combination of rules or permits for all other types of underground injection. The requirement for permits for certain categories of injection wells is maintained because ongoing State and Federal programs already specify permits for most of these installations. Furthermore, it was the intent of Congress that the Act not conflict with existing State and Federal programs dealing with this practice. Other underground injection practices are to be covered by rules or permits, at the discretion of the States, in order to provide maximum flexibility in the implementation of the program.

A system of rules in which general statements are specified, and which can be supported by enforcement authority contained in the Act, is believed to be the most practical approach for certain types of injection practices because it can cover a variety of conditions and can be adapted to different types of underground injection. Also, rules must take into account the need to protect the ground-water resources, as specified in the provisions of the Act. In other words, a rule is not intended to be a way of bypassing the intent of Congress to protect the quality of ground water used by public water-supply systems.

Many States now have some kind of permitting system applicable to certain types of underground injection, but in some cases these permits are largely administrative and may not provide the required degree of protection. Consequently, the rules to be adopted by the States will have to contain language that is more restrictive than that of a purely administrative permit. For example, a State could establish a rule stating that specific types of wastes will be prohibited from being disposed of into underground formations at certain types of facilities. Or, a rule could be promulgated to ban underground injection within specified distances from a public water-supply facility.

However, the UIC regulations provide the States with some measure of flexibility in administrative and technical controls. For example, approved existing injection wells which ultimately will require UIC permits, maybe permitted to operate under State rules for up to five years, pending a review of those facilities. Also, aquifers or parts of aquifers containing less than 10,000 mg/l of dissolved solids, but which are badly contaminated or are suitable mainly for oil or gas production, may not be designated as potential drinking-water sources,at the discretion of the States.

Extension of well casings to depths where the water contains 3000 mg/l of dissolved solids may be waived if use of the aquifer as a drinking-water source is not endangered.

The procedure for implementing the program will consist of a listing of the States over a period of years. In addition, with respect to data requirements the States will maintain an inventory of underground injection facilities, and will compile additional information needed to define hazards to drinking-water sources. The level of reporting on monitoring activities would be related to the relative hazards involved, and would be adjusted to the individual site conditions and sources of contamination.

a. Beneficial Impacts.

(1) The regulations allow a high degree of flexibility in State programs and require a minimum of changes in State institutions and administrative procedures, while at the same time bringing all injection practices listed under control. The requirements for permits should not impose any substantial new burden on State agencies.

(2) This approach is consistent with the provisions of the Act because the State programs will have to meet the minimal EPA requirements for protecting the quality of drinking water.

(3) The costs of implementing the program, from the viewpoints of both the States and the injectors, generally would not be intolerable. Few if any changes in State institutional frameworks should be needed.

(4) An improved level of protection will be provided for public health because dangerous sources of contamination will be brought under control and public water-supply facilities using ground water will be faced with fewer potential problems pertaining to water quality.

b. Adverse Impacts.

(1) Because permit and rule procedures will differ from State to State, there will be limited uniformity of procedures throughout the nation. This could hamper coordination and decision-making with regard to particular types of ground-water contamination problems.

(2) Some injectors would be put to increased expense in order to meet the new regulatory requirements and to develop alternative waste-disposal or treatment practices if their existing ones should be prohibited.

(3) Further degradation of ground-water quality would be allowed wherever the threat of contamination of an actual or potential public water-supply system is felt to be minimal. In some places, this could have adverse consequences for water users other than those dependent on public water systems.

c. Action Taken.

This intermediate alternative is recommended because it will provide new controls and additional support for State efforts to control ground-water contamination. Furthermore, it is anticipated that implementation will result in a minimum number of legal challenges and the economic impact in terms of additional costs and manpower requirements will be moderate.

C. Summary. In Section IIA, seven basic issues were discussed involving interpretations of the provisions of the Act pertaining to preparation of the State Underground Injection Control Program regulations. Various alternatives for each issue were considered. In Section IIB, these issues were combined into three procedural alternatives--a very restrictive one, a very loose one, and the intermediate one that has been adopted in the regulations. The alternatives selected for the regulations under each issue represent a combination of various restrictive, non-restrictive, and intermediate choices. Table 10 gives a summary showing which of the choices were selected for each issue.

The beneficial and adverse environmental impacts of the regulations are discussed in detail in Section III. The impacts that might have been felt from the restrictive and non-restrictive alternatives, if EPA had decided to take either of these approaches, are summarized in Tables 11 and 12. Note that substantial benefits would have accrued from the very restrictive alternative, but none from the loose alternative.

Table 10. - SUMMARY OF THE ALTERNATIVE REGULATORY PROCEDURES CONSIDERED DURING DEVELOPMENT OF THE UIC REGULATIONS

	Issue	Restrictive Regulations	Non-Restrictive Regulations	Proposed Regulations	Basis for Selection of Alternative
1.	Definition of well injection	Broad	Narrow	Intermediate	Provides increased protection within legal and economic constraints
2.	Levels of drinking water quality protection	All waters regardless of TDS content	No stipulation regarding TDS content	TDS content of 10,000 mg/l or less	Covers most drinking water sources
3.	Endangerment of drinking water sources	No degradation	Degradation if no additional treatment needed	Degradation if no additional treatment needed	Provides public health protection with least economic impact
4.	Types of regulations	All permit	All rule	Combination of permits and rules	Best fits existing State procedures
5.	Program implementation				
	A. Listing of States	Simultaneous	Staggered	Staggered	Economic constraints
	B. Program staging	Immediate	Sequential	Immediate	Recognizes differences in States in start-up of program
6.	Documentation by States	Detailed	Moderate	Detailed for permits, moderate for rules	Most adaptable to State capabilities
7.	State personnel requirements	Specified for all personnel	No specifications	No specifications	States have adequate capabilities

Table 11. - IMPACTS ON THE ENVIRONMENT FOR THE RESTRICTIVE ALTERNATIVE

Environment	Beneficial or Adverse Impacts	Long- or Short-term	Reversible or Irreversible Commitment of Resources	Retrievable or Irretrievable Commitment of Resources	Primary or Secondary Effects	Significant or Minor Effects
Water	B-Protect and improve water quality	L	I	NA	P	St
Air	A-Increase air pollution	L	R	NA	S	M
Land	B-Increase land-use opportunities	L	I	NA	S	M
Recreation	B-Increase recreational benefits	L	I	NA	S	M
Noise	---	-	-	--	-	-
Wildlife	B-Improve wildlife habitats	L	I	NA	S	M
Solid Wastes	A-Increase solid wastes	L	R	NA	S	M
Pesticides	---	-	-	--	-	-
Non-point Runoff	---	-	-	--	-	-
Scenic, historic, and archeological sites	---	-	-	--	-	-

Explanation of Abbreviations

I - Irretrievable
L - Long Term
M - Minor
NA - Not Applicable
P - Primary
R - Reversible; Retrievable
S - Short Term; Secondary
St - Significant
A - Adverse
B - Beneficial

Table 12. - IMPACTS ON THE ENVIRONMENT FOR THE NON-RESTRICTIVE ALTERNATIVE

Environment	Beneficial or Adverse Impacts	Long- or Short-term	Reversible or Irreversible Commitment of Resources	Retrievable or Irretrievable Commitment of Resources	Primary or Secondary Effects	Significant or Minor Effects
Water	A-Minimum improvement of water quality	L	R	NA	P	M
Air	---	-	-	--	-	-
Land	---	-	-	--	-	-
Recreation	---	-	-	--	-	-
Noise	---	-	-	--	-	-
Wildlife	---	-	-	--	-	-
Solid Wastes	---	-	-	--	-	-
Pesticides	---	-	-	--	-	-
Non-point-Runoff	---	-	-	--	-	-
Scenic, historic, and archeological sites	---	-	-	--	-	-

Explanation of Abbreviations

A - Adverse
L - Long Term
M - Minor
NA - Not Applicable
P - Primary
R - Reversible

III. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION.

A. Effects on Water.

1. Underground Sources of Drinking Water. More than 70 billion gallons of ground water are pumped daily in the United States for all uses, but predominantly for public-water supply and irrigation. Consequently, because the Act deals with the protection of drinking-water sources, a paramount beneficial impact of the regulations will be an enhancement of the quality of the human environment, in that drinking-water quality will be improved. In particular, better water quality will benefit public health by reducing possibilities for outbreaks of the kinds of waterborne diseases and chemical poisoning discussed previously in Section IA1.

Undoubtedly, the number of unknown or unreported incidents of harmful effects of contaminated water on health is many times greater than those reported officially. Moreover, there are many contaminants in water such as detergents, phenols, heavy metals, and sulfates that may not directly cause disease but are objectionable because of taste, odor, or long-term accumulation effects in the body. Thus, it is apparent that there is considerable room for improvement in the quality of ground water serving public-water supplies, and that the regulations constitute a step forward in reducing harmful or objectionable effects on public health.

From the broader viewpoint of overall quality of ground water in the nation, the implementation of the regulations should do much to reverse the chemical degradation of aquifers that has taken place stemming from carelessness or lack of knowledge of underground injection practices. Plumes of highly contaminated ground water have been detected beneath and downgradient from many existing and abandoned underground injection facilities throughout the country. By bringing under new and better control the estimated tens of thousands of sources of contamination of this kind, a greater awareness will be achieved concerning the contamination of ground water resulting from improper construction and operation of these underground injection systems. Setting up water-quality restrictions for injection zones and stringent requirements for constructing, operating, and monitoring underground injection devices and practices will help eliminate or retard the growth of many older plumes of wastes, as well as prevent or minimize the development of new ones.

The language of State permit or rule procedures should be formulated in a way that operators of waste-disposal facilities do not gain the impression that underground injection is a more acceptable practice than they had previously believed or that it should be adopted as a cheaper alternative to more costly treatment. Underground injection will be conducted when it can be shown that it is the most environmentally acceptable method of protecting the environment. When injection is not employed, all discharges must meet surface-water standards.

2. All Other Waters.

a. Fresh Surface Water. Controlled underground injection, as prescribed by the regulations, will in many places be an environmentally safer alternative method of disposal than direct discharge into surface waters, which is widely practiced at present. In such places, resorting to underground injection will reduce the volume and content of contaminants discharged directly into streams, thereby improving stream quality. Also, flood control will be improved in smaller streams, where effluent discharge now represents a significant proportion of the flood flow.

Where existing underground injection activities are curtailed or banned under the UIC program, and where suitable alternative methods of disposal are available, the quality of the water now seeping out of the ground to make up the base flows of streams will gradually improve, leading to an overall improvement in surface-water quality. In this connection, it should be noted that discharge of waste waters into streams will not be allowed except under an NPDES permit, which will assume that the effluent meets prevailing stream-quality standards.

The headwaters and other parts of intermittent streams in arid and semi-arid regions commonly go dry in non-rainy seasons, except where the flow is sustained by inflow of sewage and other effluents (for example, in parts of Arizona and New Mexico). If, as a result of the regulations, the effluents were to be disposed of through wells, parts of the streams would go dry for longer intervals between periods of rain. The impact would vary in degree, but generally should not be too significant, since these types of streams commonly lose most or all of their flow naturally through the stream bottom into underlying shallow aquifers. In humid regions, cessation of effluent discharge into the headwaters could also cause those parts of the stream channel to go dry for longer periods. However, part of the water from shallow injection facilities that enters the aquifer near the headwaters of the stream could reappear as seepage in the channel farther down gradient.

Non-point runoff of storm water to rivers or to the sea generally will not be impacted by implementation of these regulations. Where storm runoff is conducted through artificial ditches and channels to a drain well, contamination from the drain well to underlying aquifers will require stricter surveillance and control under the proposed regulations and, thereby, benefit ground-water quality by preventing or reducing contamination.

Non-point runoff in agricultural areas that contains pesticides, nitrates, and herbicides could come under regulatory control where such runoff is conducted to drainage wells that penetrate underlying shallow aquifers.

b. Coastal Waters. Atlantic, Pacific, and Gulf coastal waters represent billions of dollars in value in tourism, fishing, boating, and other recreational activities. In such places, where underground injection is authorized under the UIC program as a preferred alternative to discharge of waste effluents into coastal waters, those waters will receive reduced loads of contaminants such as pathogens, toxins, nutrients, and other dissolved minerals. Improvements of this kind are already being noted in Florida, where large amounts of treated sewage effluent are now being injected underground instead of being discharged through ocean outfalls. Also, any improvement in the quality of streams discharging into coastal waters that results from the UIC regulations will help to improve the quality of those coastal waters. No significant adverse impacts are anticipated.

c. Wetlands. The proposed regulations will protect wetlands against further degradation from poorly operated and controlled shallow injection systems. Because the water table is close to the land surface in wetland areas, shallow injection wells often do not operate efficiently, and may overflow and leak contaminants to the land surface. Supervision and control of these facilities under the regulations will result in either shutdown of or improvement in the operation of defective systems.

Some short-term damage or destruction of wetland vegetation could result locally during construction of injection devices, such as brine-disposal wells and secondary recovery wells, which are supporting facilities for oil and gas well fields located in or near coastal wetlands. Wetlands contamination can be minimized and reduced by careful housekeeping operations and subsequent reclamation programs.

B. Effects on the Non-Water Environment.

1. Air. Pumping operations for deep and shallow well injection will not result in air pollution except on a very minor scale. Most pumps are electrically driven and only a small number are powered by gasoline or diesel powered engines. Moreover, many underground injection processes are gravity controlled and do not require pumping.

Controlling underground injection should not cause any major shifts in industry or population that would result in a shift in air-pollution patterns, because many of these existing injection operations most likely will be approved by State regulatory agencies, or sufficient time will be granted to upgrade or shut down these systems in accordance with the UIC requirements. Dust, noise, and fumes from vehicles used during the construction and operation of new injection facilities will have only minor secondary adverse impacts on air quality locally, which can be minimized by careful construction and operational practices. The minor adverse secondary impacts on air quality will be far outweighed by the beneficial effects of improved water quality.

2. Land. Insofar as injection of fluids in wells will be under closer supervision of regulatory agencies than at present, land resources in the vicinity of those facilities will be less impacted by careless spills or storage of contaminants on the land surface, dispersal of wastes by overland runoff, or by seepage to the land surface of contaminated ground water where the water table is at very shallow depth. Overall improvement in water quality resulting from compliance with the regulations should tend to enhance local land values.

However, where saline brine or other contaminants are accidentally spilled on the land surface in the vicinity of injection wells, some soils and soil bacteria would be destroyed because of the high concentrations of the contaminants.

Some land would be taken out of general use to build disposal facilities but this would represent only a very small percentage of the land used for other productive purposes on a nation-wide basis. Some soil would be removed on a one-time basis during excavation of wells but this material could be used for fill elsewhere. Likewise, the wells themselves, could be backfilled and the land reclaimed for other purposes if the facilities were shut down.

3. Recreation, Solid Wastes, and Pesticides

a. Recreation. Many recreational ponds, lakes, and streams in the eastern and central parts of the country are hydraulically connected to the water table and, consequently, receive inflow from shallow aquifers. Because the regulations are designed to upgrade the quality of underground drinking-water sources, the quality of such interconnected surface-water bodies would also be improved. This, in turn, would provide better aesthetic and healthful water-quality conditions for swimming, fishing, camping, and drinking-water purposes in recreational areas.

b. Solid Wastes. Although thousands of unregulated or partly regulated landfills of all types are major point sources of ground-water contamination, these regulations should have little effect on the practices of solid-waste disposal. These regulations will impact such practices only if: (1) leachate from a landfill is collected and injected through a well, and (2) if the regulations produce a shift from injection of some fluids to land filling of the same fluids.

c. Pesticides and Herbicides. Pesticide and herbicide application would not be significantly impacted by the regulations. However, liquid pesticides or waste products from pesticide manufacture which are disposed of in injection wells, will come under the regulations.

4. Miscellaneous Activities.

a. Wildlife. Fish and animals that depend on streams and lakes connected to shallow aquifers for drinking water will benefit from a health viewpoint as a result of improved groundwater quality. Similarly, plants whose roots tap shallow water tables will benefit from the maintenance or improvement of the quality of ground water stemming from compliance with the proposed regulations.

Construction and operation of injection facilities that are patrolled or fenced may restrict the movement of or otherwise temporarily or permanently disturb natural habitats of some wildlife in scattered areas. The adverse impacts of such disturbances would generally be outweighed by the potential for improvement in water quality from properly regulated injection practices.

b. Scenic and Historic Places. Little or no impacts are anticipated on scenic or historic places because of the flexibility in locating most injection well facilities. The chances that some of the tens of thousands of existing or proposed injection facilities could penetrate historical or archeologically valuable materials is very small on a nationwide basis. Contacting appropriate State or county agencies can provide some advance warning of possible problems of this kind on a site-by-site basis. This will permit adjustment of the location of the facilities, where feasible, or scheduling of visits by specialists to collect important items and other data of interest in these categories.

C. Effects on Non-Federal Governmental Agencies.

1. Effects on State Institutions. The long-term impact of the regulations on the institutional frameworks of the States should not be severe, although initially some reorganization and additions of manpower may be needed. The regulations conform to many State constitutional capabilities, so that it is anticipated few State legislative changes will be needed in order to allow the States to participate in the program. Moreover, many existing State agencies should be able to implement the UIC program by assigning the new duties to the most qualified departments or units. Section IEc of this report discusses the current status of State injection regulations and controls.

In a broad sense, the additional work that the States will have to undertake in order to participate in the program can be grouped under several major headings, each of which is discussed below:

a. Initial Preparation of the State Program. The regulations stipulate that each State is to prepare a plan or program for implementation of the underground injection control program and that this plan is then to be submitted to EPA for approval. In order for a State to establish a technical foundation for its program, certain preliminary knowledge of the ground-water environment must be available. Few States have thus far made a detailed evaluation of their ground-water resources, and knowledge of the chemical content of the ground water, both natural and contaminated, in all parts of a State commonly is fragmentary or only poorly defined. Thus, in order to participate in the UIC program, at least some States will have to undertake studies and investigations to determine which aquifers are suitable for drinking-water sources and which are suitable for receiving contaminated fluids. Making these decisions will not be an easy task in some localities, because an aquifer may be a drinking-water source in one locality and may contain highly saline water in another. Because the line or boundary separating the fresh and salty zones in such aquifers is not fixed in space and can be shifted as a result of pumping from wells, a State may have difficulty in being able to rigidly classify aquifers or parts of aquifers with respect to use for underground injection.

The acquisition of basic data on the geologic and hydrologic elements of the ground-water situation is commonly a task calling for years or decades of study by State geological surveys, by Federal agencies such as the U.S. Geological Survey, and by universities and consultants. Thus, it may be necessary for some States entering the program to rely on a preliminary description of the hydrogeologic environment and to take steps to gradually revise and upgrade this description. It is realized that even under the best of circumstances not all of the States will be able to develop a clear and concise picture of their ground-water recources at the very outset of the UIC program.

The regulations prescribe procedures for holding public hearings in the States prior to adoption of the program, and also indicate what steps have to be taken in the event that the first draft of the program does not conform with requirements. These initial setting-up activities will necessitate a certain degree of cooperation among existing State institutions, a review of State statutes and legal constraints, a definition of new manpower and budgetary needs, and in some instances reassignment of duties among State institutions so that they will be able to carry out the regulatory program once primacy is granted. As noted, the new responsibilities should not constitute a problem in States that are already organized to handle a variety of regulatory programs.

b. Permitting Procedures and Recordkeeping. The burden of instituting procedures for issuing permits, writing rules, and organizing the day-to-day recordkeeping and supervision will differ from State to State. In States where the capability for issuing such regulations and for handling the more routine parts of the program already exists, implementation of the UIC regulations should not cause severe disruption.

In States where little or no attention has been paid in the past to ground-water contamination, it may be necessary to organize new units or departments in order to develop an acceptable program. Typically, such a department would have to maintain central files containing information on injectors, the engineering details of injection facilities, the types and quantities of fluids being injected, the monitoring procedures being followed by the injector, periodic reports from injectors, and similar matters. In States that have few underground injection facilities, the amount of recordkeeping will be minimal. In highly industralized States and in States heavily involved in oil and gas production, the situation can be much more complicated because hundreds of underground injection systems will come under scrutiny.

c. Monitoring and Enforcement. Monitoring and enforcement of the provisions of the regulations will call for an increase in workload in some States. In those States having few injection facilities, providing field inspection should not be a problem. In other States, however, it will be necessary to organize field operations for visiting, inspecting, and monitoring underground injection facilities on a continuing basis. In addition to staffing requirements, vehicles must be provided and budgetary outlays must be made for travel and field expenses for such activities.

The regulations also stipulate that enforcement is a responsibility of the States, and that each State shall develop procedures for halting or eliminating injection practices that endanger underground drinking-water sources. Suggested procedures for actions to be taken by the States would involve filing law suits, levying fines, and other actions to halt or abate injection practices which endanger underground drinking-water sources. When these procedures are adopted, the State will have to utilize the services of its attorneys and legal departments.

d. Staffing Requirements. Trained ground-water specialists will be needed to oversee and evaluate underground injection operations. Although many permitting systems throughout the country are quite routine, in the sense that an applicant has to submit only a limited amount of information in order to receive a permit, this approach will not be acceptable in the case of the UIC program. The emplacement of contaminated fluids in the subsurface environment is not well understood by most people, and can be evaluated only by specialists intimately familiar with the occurrence and behavior of ground-water resources. To develop a meaningful program for underground injection, knowledge of hydrology, geochemistry, geology, and the hydraulic behavior of aquifer systems is needed. Thus, although much of the routine work to be done in connection with the program will be clerical and administrative, the intent of the regulations will not be fulfilled unless competent ground-water personnel exercise close control in evaluating applications for underground injection facilities and their operations.

Locating the necessary people to fill these positions in State agencies may be a problem in some States, unless they can be reassigned from other jobs within the existing institutional framework. In recent years, with the increased emphasis on control of water contamination, the demand for skilled specialists has risen accordingly. The National Water Well Association and others have pointed out that there is only a limited pool of skilled manpower available, and that universities will have to expand their training programs if the quality of technical personnel is to keep pace with new regulatory requirements. Consequently, it is anticipated that at the outset not all of the States will be able to provide the highest level of professional supervision needed to fully conform with the requirements of the regulations.

No in-depth study has been made of how much additional effort will be required on a State-by-State basis to conform with the regulations for the underground injection control program. However, some indication of the kinds and numbers of personnel that will be needed by the States to carry out the provisions of the UIC program is given by the results of previous manpower studies that are outlined below.

1. Manpower Study for P.L. 92-500. A study made for EPA by Abt Associates, Inc., entitled "Manpower and Training Needs of State Water Pollution Control Agencies", was designed to measure the human resource impact of P.L. 92-500. Specifically, it was aimed at providing systematic information on the numbers and types of State agency personnel needed to implement P.L. 92-500 and the needs for training of such personnel.

The approach followed by the investigators basically was to identify how many sources of contamination might have to be evaluated in each State and then to define the numbers of personnel that would be needed. Their conclusion, based on estimates provided by the Manpower Planning Branch of EPA, was that about 2,700 technical and support personnel would be required in the 50 States to cope with all of the provisions of P.L. 92-500. As would be expected, States having the most pollution sources had the largest manpower requirements. California, for example, needed 117 people; Illinois, 106; Michigan, 100; New York, 109; and Pennsylvania, 116. At the other end of the scale, South Dakota, Vermont, New Hampshire, Delaware, and Hawaii required about 27 people each.

It should be kept in mind that the foregoing manpower estimates applied to all of the provisions of P.L. 92-500, and that the manpower needs for the UIC program should be substantially smaller. In some States that are already heavily involved in control of underground injection practices, there may be little or no need for additional staffing.

2. The Model Ground Water Law Study. The National Water Well Association, under a contract with EPA, has examined the overall problem faced by the States in protecting ground-water resources, and has drafted a hypothetical Model Law and Regulations on how a State, under an ideal situation, could organize itself along these lines. This hypothetical Model Law was written in response to the ground-water requirements of P.L. 92-500. The findings of the study, as discussed below, give some indication of what the States might have to do if they decide to incorporate the objectives of the UIC program with a complete plan to control

all ground-water activities.

NWWA recognizes that the Model Law in its entirety is far too ambitious to fit easily into existing State institutional frameworks, because ideally it would call for creation of a new consolidated State agency concerned specifically with ground water. Thus, from a practical viewpoint, adjustments could somehow be covered by existing institutional arrangements. This in turn would accentuate the need for planning and coordination among the numerous State departments involved with water, and NWWA believes that this would necessitate creation of a special planning and coordination section in the State. This section would identify critical ground-water areas, investigate methods of controlling and preventing pollution and contamination, make recommendations concerning policy and legislation, coordinate activities with the involved agencies, and compile and disseminate information, along with other similar tasks.

Other sections of the ideal State agency deal with permits, monitoring and data collection, enforcement, and research. The requirements for these sections would differ from State to State, again depending on the intensity of the effort needed. In all likelihood, most States would delegate the different functions to existing departments or sections, while establishing some sort of overall coordinating procedures.

2. Effects on Local Government. Local governments at the county and city level may be impacted by the regulations in

several ways. First, certain types of underground injection systems, such as urban runoff drainage wells, and conventional municipal disposal wells are owned and operated by local governments who may have to upgrade some facilities in accordance with UIC regulations. Secondly, county and city Departments of Health and Environmental Protection may be delegated the responsibility by some State agencies to hold hearings and issue permits on local facilities. Therefore, under the UIC program, the States will have to play a coordinating rule with these local agencies in the permitting and inspecting procedures of the regulations. This may require small increases in local budgets and manpower needs.

3. Effects on Interstate Agencies. Existing interstate relationships and interstate agencies could be impacted to some degree by the regulations. Because many aquifers extend across State lines, variations in the application of the proposed regulations by adjoining States may result in varied impacts on the water quality, according to the looseness or rigidity of the individual State's UIC program.

In addition, there are about a dozen interstate water-pollution control or water-regulatory agencies in the United States that are concerned directly or indirectly with control of water quality in their respective river basins. These agencies range in size from bi-state associations, such as the Klamath River Compact Commission, composed of California and Oregon, to large organizations, like ORSANCO, which is composed of eight States, or the Delaware River Basin Commission, which includes the Federal government as well as four States.

Several of the interstate commissions are already involved with preventing water contamination by underground injection. For example, ORSANCO has prepared regulations on deep-well injection and the Delaware River Basin Commission has a formal published policy which gives the Commission substantial authority to prevent or abate ground-water contamination. Thus, some existing interstate commissions that are already conforming with the spirit of the UIC regulations may not have to increase the intensity of their controls, whereas some will have to develop controls for the first time, particularly where the interest has been mainly in controlling surface-water quality. In either case, these agencies might need additional funds and staff under the UIC program.

Some commissions may have legal, policy, and technical difficulties in controlling contamination where some of their member States have received primacy under UIC regulations and others have not. This problem will be even more complicated where the Federal government is a participating member of an interstate commission.

D. Effects on Federal Agencies.

1. Environmental Protection Agency.

a. Office of Water Supply. The regulatory program will have an effect on the operations of this office, because EPA's role will be to provide assistance and guidance to the States. It is not anticipated that EPA will have to administer the UIC program in any State. Nevertheless, some additional manpower resources will be required at increased cost to the Federal government to provide necessary coordination with regional offices, other Federal agencies, other EPA programs, and the States. Impacts on the Office of Water Supply that do develop in response to the regulations will be long-term.

b. Other EPA Offices. It will be necessary to increase the number of technically competent ground-water specialists in the EPA regional offices to provide technical assistance and guidance needed by the States. It is anticipated that these new people will not be available initially because it is estimated that there are only about 1,000 such specialists in the United States now. Moreover, nearly all are presently employed, and competition for them will come from the States and from industry. However, the demand eventually will be filled as new individuals acquire the training necessary to meet the job requirements.

The proposed program should have some effects on other EPA offices. The most significant one will be the increased competition for available resources of manpower and money.

2. Other Federal Agencies. As is generally the case with new legislation, some conflicts will be found to exist with previous Federal laws ans regulations. A potential area of conflict will be, for example, with the Mineral Leasing Acts, under which the Department of Interior has the responsibility for regulating oil and gas activities on Federal land. Conflicts also may arise from the application of the regulations to Indian lands. Another area of potential conflict will be in States which presently do not have authority over the handling and disposal of radioactive liquids, even on private land. Where States have not assumed this authority, it rests with the Nuclear Regulatory Commission, which then licenses underground injection facilities.

E. Effects on Well Injection Practices. As discussed in Section II, a variety of types of underground injection systems are included under the underground injection control regulations. These include waste-disposal wells and engineering wells, injection wells related to oil and gas production and drainage wells. The anticipated effects of the proposed regulations on each of these types of underground injection are summarized below.

1. Waste-Disposal Wells and Engineering Wells. The regulations contain a detailed coverage of conventional industrial and municipal injection wells. Primarily, this is because considerable thought and effort have been given to the development of such regulations by a number of State, interstate, and Federal agencies over the past 15 years, thereby providing

substantial background material that could be used in the formulation of that portion of the UIC regulations.

A reflection of this is the EPA policy statement on subsurface emplacement of fluids (ADS-5), which contains provisions and requirements selected from among those employed by various States and suggested by numerous specialists in injection well technology. The Congress viewed provisions of this policy statement as applicable to the UIC regulations, as evidenced by statements in the House Report (93 -1185, p. 29 and 31) that the Congress intended that EPA would use the policy guidelines and types of measures included in that document as a basis for the regulations. Because of the history that preceded the development of the UIC regulations relating to industrial and municipal injection wells, it is not anticipated that the regulations will substantially alter current practices relating to those wells.

The regulations require permits for new and existing conventional industrial and municipal wells; most existing wells of these types in the country are presently under State permit. The water pollution Control Amendments of 1972 require that, for a State to have authority to administer its own NPDES permit program, it must have the authority to issue permits for disposal of contaminated fluids into wells. Twenty-four States have NPDES program authority and an additional 15 States are known to have existing drilled, cased, and cemented disposal wells under some form of State permit. In these 39 States, the proposed permit requirements should present little difficulty for existing injectors, since most of the States allowing such wells now have technical requirements similar to those in the UIC regulations.

The regulations require provisions for notice of all UIC permit applications to the public, to any persons or groups requesting notices, to other appropriate Federal, State, and local government agencies, to other potentially affected States, to appropriate interstate agencies, and to foreign countries. Also, public hearings on UIC permit applications are required if there is significant public interest. The requirements for notice and public hearings go beyond the scope of present procedures in all States, as far as is known, and will add to the administrative burden of the injector as well as to the State and may cause some delay in processing permits.

The regulations provide that no permit for a conventional industrial or municipal injection well will be issued unless it is shown that the resulting injection will not endanger drinking-water sources. The provision against endangerment of drinking-water sources should not greatly affect present practices. Most such wells are now injecting into aquifers with dissolved-solids contents greater than 10,000 mg/l and, if properly constructed and operated, will not endanger drinking-water sources. In a few cases, injection is into aquifers containing brackish water, but with less than 10,000 mg/l TDS. These injectors will have to show that well injection does not endanger drinking-water sources.

Several technical requirements are proposed for UIC permits. These are generally consistent with present practice or else are minor administrative requirements that should not greatly interfere with the existing injectors or place undue burden on new ones. One requirement that is mentioned in the House Report (p. 30), and also in the regulations, is the provision for adequate financial resources to deal with injection systems that are improperly abandoned or that may otherwise cause contamination of drinking-water sources. Most States now require bonds to assure adequate well plugging upon abandonment. However, there is no known precedent for bonds or liabilities that would be adequate to deal with a major ground-water contamination problem.

The requirements for recording and reporting the results of monitoring by the injector are within the scope of present practices. The provision that such records be kept by the injector for a minimum of 5 years after a well is abandoned should have only a minor impact.

The requirements discussed above for conventional industrial and municipal wells apply also to shallow municipal and industrial wells, subsidence control wells, salt-water intrusion barrier wells, ground-water recharge wells, solution-mining wells, gas-storage wells, and geothermal wells. Solution-mining wells are presently subject to nearly the same requirements as conventional industrial and municipal injection wells in Michigan and are under some form of control in several other States where they are used.

The proposed regulations will have some adverse impact on all solution-mining wells by increasing their cost and delaying their construction. The prime concern for regulating these wells is not the mining process used but the method by which the secondary water and spent solution are disposed. Generally, this solution is reinjected into the aquifer from which it comes or into another aquifer. These reinjection practices must be controlled to prevent endangerment of drinking-water sources.

Regulations of the type specified have not generally been applied previously to subsidence control wells, sea-water intrusion barrier wells, or ground-water recharge wells used for aquifer augmentation, because these wells are installed only for beneficial purposes. The regulations have been applied to these wells to prevent uncontrolled disposal activities which may endanger drinking-water sources.

Regulation of these wells will unquestionably interfere somewhat with their use. For example, hydrologic, geologic, and engineering data will have to be collected and evaluated before any subsidence, barrier, or recharge well is authorized. However, it should be noted that most wells of this kind already are under some local control because it is recognized that they can have a significant impact on the environment. However, in the case of shallow, municipal and industrial wells which are injecting wastes into ground water containing less than 10,000 mg/l of dissolved solids, the impact may be severe. All of the wells will have to be permitted and, in some instances, may be shut down at the discretion of the States, if their operation endangers an underground drinking water source.

2. Injection Wells Related to Oil and Gas Production. Separate provisions have been set forth under Subpart D for wells used for disposal of brine or other fluids that have been brought to the surface during oil or gas production and for wells used for injection during secondary or tertiary recovery of oil or gas. The regulations require that, in States with authorized UIC programs, any such wells placed in operation after the effective date of the regulations will be under permit. The requirement for a permit, in itself, should not greatly interfere with the use of these wells, because permits in one form or another are now generally required by most States in which they exist.

Annular injection is considered to be undesirable practice which is not recommended for long-term disposal due to the potential for ground-water contamination from corrosion and short circuiting of injected fluids through holes in the casing. This practice should be phased out completely to insure protection of drinking-water sources. New disposal wells or other disposal methods will be needed to handle brine now disposed of by annular injection.

Brine-injection wells in operation on the effective date of the regulations may be regulated by rules for a period of five years from the effective date if they do not endanger drinking-water sources. All these wells shall be reviewed within five years and, if they do not endanger a drinking-water source, they may continue in operation under a permit. Those found to endanger a drinking-water source must be remedied or they shall be plugged and abandoned. It is unknown how many existing wells will require remedial action as a result of these regulations. Many operators may abandon wells rather than invest the additional capital needed to meet the requirements.

Applications for UIC permits for new wells are to be widely distributed and public notice is required. Any interested or affected person or agency may request or petition for a public hearing. These requirements may cause some delay in construction of new wells.

The requirements for a UIC permit application for a new well go beyond those presently required in many of the oil-producing States. Acquisition of some of the data to fulfill permit application requirements will add slightly to the cost of these wells and may cause minor delays in their construction. State-issued permits for new wells will contain specific requirements regarding casings, maximum volume of fluid to be injected, maximum surface pressure, inspection and monitoring schedules, contingency plans, and plugging and abandonment procedures. They also will contain notice that the permit may be modified or revoked. The details of these requirements will be set by the States;

therefore, the exact impact on any one injector is unknown.

If improperly completed or plugged wells are within a one-half mile radius of the proposed injection well and if these abandoned wells will cause the disposal project to endanger drinking water, the permit will be withheld until remedial action is taken to prevent endangerment. If remedial action is not taken, the application may be denied. Often these abandoned wells are difficult to locate and recondition (Pasini and others, 1972). Enforcement of the regulations may prevent and eliminate the use of brine injection wells in some places, however, the impact should not be sufficient to interfere with the production of oil and gas.

3. All Other Underground Injections. It is specified in Subpart E that the following types of underground injection may be regulated by permit or by rule: (1) urban runoff drainage wells, and (2) agricultural drainage wells.

The regulations under either permits or rules are brief, but nevertheless contain one requirement that must be considered when planning the use of these injection practices. This requirement is that no permits will be issued or injection allowed by rule that endangers drinking-water sources.

The interpretation selected requires that no well injection into aquifers containing drinking water will be allowed if additional treatment will be required by the water user. It seems inevitable that some present injectors will have to modify or abandon their present systems and that new injectors will have to expend more effort in planning, constructing, and operating injection systems than has previously been necessary.

For injection wells regulated by permit under Subpart E, public notice will be given and hearings will be held if the Director determines that the application raises questions of endangerment of drinking water resources. The public will be given an opportunity to comment on the application. Moreover, no permit shall be issued if underground drinking-water sources are endangered.

F. Summary. Table 13 summarizes the anticipated beneficial and adverse impacts associated with the regulations. (Tables 11 and 12 summarize impacts for the restrictive and loose versions of the regulations that were considered but rejected.) Each impact is examined as to its duration, reversibility, retrievability, order, and relative significance. In evaluating the duration of the impacts, it was assumed that whatever regulations were promulgated would remain in effect for an extended period. Therefore, all impacts are considered long term, except those like manpower shortages and conflicts with existing legislation, which are considered to be short term.

If it were desired to reverse some impacts, this could be accomplished by revising the regulations or making other adjustments. Therefore, the only impacts considered irreversible are those that will remain even if the regulations should be changed. An example of an irreversible beneficial impact is an improvement in water quality. Water could be degraded later, but any incremental improvement that occurs during a period of protection cannot be taken away. An irreversible negative impact is the use of materials and energy that cannot be regained. The development of additional trained manpower is considered irreversible because any new trained technical personnel would remain, even if the regulations were subsequently revised to reduce the need for them.

It was judged that reversibility and retrievability differ in that the former applies to actions, whereas retrievability applies only to resources like money and materials, and none of these are considered retrievable after commitment. For example, the expenditure of Federal funds for the proposed program is reversible; it can be stopped at any time by a change in the law. On the other hand, the expended funds are irretrievable.

Impacts are classed only as primary and secondary. Primary impacts are considered to be those resulting directly from the regulations, such as modification of State programs. Secondary impacts are considered to be those that develop in response to the primary ones; for example, the costs of modified State programs. An impact is classified either as primary or secondary; it cannot be both.

The classification of impacts as significant or minor was judgmental and was not subject to a quantitative evaluation. An anticipated shortage of manpower for the program was considered to be significant initially, because of the very small supply of available persons trained in ground-water hydrology. However, it was considered to be ultimately a minor impact when compared with overall governmental and industrial manpower requirements.

TABLE 13. SUMMARY OF IMPACTS OF THE PROPOSED ACTION

Subject of Impact	Beneficial or Adverse Impacts	Long or Short Term Impacts	Commitment of Resources		Primary or Secondary Effects	Significant or Minor Effects
			Reversible or Irreversible	Retrievable or Irretrievable		
1. Institutional						
A. Federal	B-Minimum effect on EPA	L	R	NA	P	St
	A-Conflict with other Federal legislation	Subject to resolution.	R	NA	P	M
B. State	B-Allow State flexibility.	L	R	NA	P	St
	B-Conform to existing State organizations.	L	R	NA	P	M
	B-Enhance State cooperation	L	R	NA	P	St
C. Local	B-Little interference.	L	R	NA	P	M
	A-Increased local supervision	L	R	NA	P	M
2. Resources						
A. Costs	B-Minimum Federal cost	L	I	NA	S	St
a. Institutions	A-Increased and competing EPA budgets.	L	R	I	S	M
	B-Federal grants to States	L	R	I	S	M
	A-Increased State cost	L	R	I	S	M
	A-Increased local cost	L	R	I	S	M
b. Injector	B-Reduced liability	L	R	NA	S	M
	B-Increased technical assistance	L	R	NA	S	M
	A-Increased costs.	L	R	I	S	St
c. Public	B-Reduced water-supply costs	L	I	NA	S	M
	A-Increased taxation	L	R	I	S	M

TABLE 13. (Continued)

Subject of Impact	Beneficial or Adverse Impacts	Long or Short Term Impacts	Commitment of Resources		Primary or Secondary Effects	Significant or Minor Effects
			Reversible or Irreversible	Retrievable or Irretrievable		
B. Manpower						
a. Institutions	B-Increased technical capability	L	I	NA	S	St
	A-Demand will exceed supply	S	I	NA	S	St-Initially M-Ultimately
b. Injector	A-Demand will exceed supply	S	I	NA	S	St-Initially M-Ultimately
C. Physical Resources						
a. Energy	A-Increased energy requirements	L	I	I	S	M
b. Materials	A-Increased material requirements	L	I	I	S	M
3. Environment						
A. Water	B-Protect & improve water quality	L	I	NA	P	St
	A-Some water pollution will be allowed	L	R	NA	P	M
B. Air	A-Increased air pollution	L	R	NA	S	M
C. Land	B-Increased land-use opportunities	L	I	NA	S	M
D. Recreation	B-Increased recreational benefits.	L	I	NA	S	M
E. Noise	B-None A-None					
F. Wildlife	B-Improve wildlife habitats	L	I	NA	S	M
G. Solid Wastes	A-Increased solid wastes	L	R	NA	S	M

TABLE 13. (Continued)

Subject of Impact	Beneficial or Adverse Impacts	Long or Short Term Impacts	Commitment of Resources		Primary or Secondary Effects	Significant or Minor Effects
			Reversible or Irreversible	Retrievable or Irretrievable		
H. Pesticides	B-None A-None					
I. Nonpoint Runoff	A-Increased runoff	L	R	NA	S	M
J. Scenic, Historic, and Archeological Sites	B-None A-None					
4. Public Health						
	B-Protect public water-supply sources.	L	I	NA	S	St
	A-Tolerates low-level ground-water pollution.	L	R	NA	P	M

Explanation of Abbreviations

A - Adverse; B - Beneficial
I - Irretrievable
L - Long Term
M - Minor
NA - Not Applicable
P - Primary
R - Reversible; Retrievable
S - Short Term; Secondary
St - Significant

IV. ADVERSE IMPACTS THAT CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

A. Effects on Water.

In places where underground injection is curtailed or prohibited, and where injectors are required to dispose of wastes into other waters, some deterioration of the quality of those waters may result. However, the impact should not be large, as all requirements of P.L. 92-500 must be met by the discharge. On the other hand, if injection is chosen as a preferable alternative to disposal into surface waters, some reductions in the flows of streams, particularly intermittent streams and the headwaters of other streams, may follow. From an overall viewpoint, such reductions in surface-water discharge will not be significant. Cancellation of injection practices in scattered localities will decrease recharge to aquifers locally, with a consequential possible lowering of ground-water levels. In general, primary adverse impacts of this kind would not be significant and the loss in recharge will be counterbalanced by the improvement of ground-water quality. Some minor low level water contamination will be tolerated, if it does not endanger drinking water.

B. Effects on the Non-Water Environment.

In some places where existing injection practices are cancelled or prohibited, injectors may have to relocate their facilities or resort to alternative methods of disposal. This could lead to local secondary adverse impacts on land at the new disposal sites. Generally, however, the benefits to drinking-water quality should more than offset these adverse secondary impacts. Some minor air pollution may occur locally from injection facility operations. Scattered parcels of land will be taken out of use for injection facilities but such losses will be outweighed by the economic gain in improved water quality.

C. Effects on Governmental Institutions.

Primary adverse impacts could arise from conflicts between some existing Federal laws and regulations and the UIC regulations. For example, under the Mineral leasing Acts, the Department of Interior is responsible for regulating oil and gas activities on Federal land. Similarly, conflicts of jurisdiction may arise on Indian lands. Furthermore, some States presently do not have authority over the handling and disposal of radioactive liquids, which commonly rests with the Nuclear Regulatory Commission.

In some States, new legislation will be needed to enable the States to conform with the requirements of the regulations. For example, injection practices that are not now being regulated by States may require new statutory authorizations. However, these types of problems are not unusual since States commonly change previous statutes as new environmental controls are implemented on either the State or Federal level.

Governmental agencies at the county and city level could be impacted adversely to a minor extent where the new regulations conflict with certain permitting procedures that are delegated to those local agencies. For example, some County and City Departments of Health and other local agencies presently have the responsibility for holding hearings and issuing permits on local injection facilities. These local program will have to be adapted to the requirements of the new State regulations so that the responsibilities for implementation are taken care of in the most efficient manner.

In river basins where interstate agencies have major responsibilities for pollution control and related water-resource matters, problems will arise if all the member States of these agencies do not adopt identical regulatory procedures in compliance with the UIC regulations. The statutory authorizations for these interstate agencies would have to be modified in some instances to reflect these differences among the States and to properly protect aquifers that cross State lines.

D. Effects on Underground Injection Practices.

This section discusses several primary adverse impacts of the regulations on the UIC program. Although these are classed as primary it should be remembered that primary in this case does not refer to the numbers of injectors affected. Furthermore, these adverse impacts are expected only on a small portion of each injection practice category. Some injectors will have to halt existing underground injection practices and turn to other alternatives for disposal or treatment fluids. In addition, some injectors will incur new costs in responding to the requirements of the regulations and in providing technical backup data with regard to the emplacement and movement of waste fluids in the subsurface environment. Certain types of injection facilities will have to be regulated by permits, and this will involve new monitoring and control costs on the part of the injector. The injector will be further impacted by the need to be represented at public hearings, presentations, and other negotiating sessions with State agencies.

Because the proposed regulations provide that the operator of a facility must demonstrate that the injection will not endanger drinking-water sources and is the most acceptable alternative, study and preparation of reports will be needed in many instances to satisfy the permitting requirements. Injectors will in some instances be faced with additional costs if the only acceptable environmental alternative is expensive treatment.

Another requirement of the regulations that will have a secondary adverse impact in some cases is that injectors must undertake measures to assure adequate financial resources for dealing with injection systems that are improperly abandoned or that may otherwise cause contamination of drinking-water sources. It is unknown, at this time, what these measures might be. Because wells used for subsidence control, retarding salt-water encroachment, and artificial recharge for augmentation of aquifers generally have not been put under a closely controlled permit system in the past, some minor impact on these operations will be felt. But, because of the high levels of geohydrologic and engineering studies required before any of these projects is undertaken, there should be little change in current practice.

Wherever wells used in the oil and gas industry for brine injection and secondary recovery are found to endanger a drinking-water source, they may have to be modified or abandoned. The specific technical requirements of the regulations with regard to these wells will call for some increased expenditures by well owners. Also, because the proposed regulations have requirements with regard to improperly plugged wells, field work will have to be undertaken to locate and rehabilitate abandoned wells where necessary.

The requirements for protecting aquifers containing potable ground water with surface casing will require some oil and gas producers to spend additional funds for drilling new injection wells, with extra casings and packers, which will increase the competition for materials.

Where permitting of certain injection wells is specifically required, it may prove necessary to undertake a case-by-case examination of existing and new underground injection system. It seems inevitable, in this connection, that some injectors will have to modify or abandon their existing injection wells.

The costs to all levels of government, injectors, and others in terms of additional monitoring, record-keeping, and manpower as an outcome of the regulations cannot be estimated with confidence at this time but are expected to be small.

It should be expected that some injection facilities will experience breakdowns or equipment failures during their operation, which will necessitate emergency actions or changeovers to alternative disposal methods, as required by the regulations. This could result in temporary escape of contaminants to the environment requiring the operators to take corrective measures.

V. RELATIONSHIPS BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY.

In principle, underground injection is not really a disposal method but is more a procedure for storing waste fluids in the subsurface environment. The storage capacity for fluids in a subsurface environment is truly immense, and is many orders of magnitude greater than the storage volumes that conceivably could be occupied by contaminated fluids within the near future. Thus, it is reasonable to allow underground injection, under controlled conditions, without vastly increasing the risks of contaminating public-water supplies for long periods of time to come. When injection is allowed in portions of aquifers that cannot reasonably be expected to be used as a drinking water source, then the procedure can be thought of as essentially harmless.

Notwithstanding, the storage volumes of aquifers are finite, and some aquifers have relatively limited storage capacity in terms of the volumes of fluids that might be injected into them. The States will have to inventory their hydrologic resources carefully to discriminate between aquifers having limited storage space and those having very large storage space with relation to water demands on those systems.

Generally, water-wells draw from shallowest water available for water-supply purposes, since there is no real advantage to drilling deeper and more costly wells if the upper water zones are adequate. Consequently, in a sense, the deeper the injection horizon, the less significant is the actual or potential threat to drinking-water supplies. Obviously, there are exceptions to this general statement in places where the best aquifers are the deepest ones. For example, in many parts of the Atlantic and Gulf Coastal Plains, waters to depths of about 2,500 feet are fresh or nearly fresh and have potential value for public-water supply use. Therefore, the State will have to carefully consider this eventuality in deciding where underground injection is to be allowed.

Thus underground injection should be thought of as a temporary solution to a disposal problem because ultimately some damage to the physical environment may begin to take place when the volume of injected fluids becomes extremely large with respect to the storage capacity of the aquifer systems. While an analysis of this trade-off requires a case-by-case determination, it is probably correct to say that the volumes of contaminants presently being injected in the United States are relatively insignificant in comparison to the total available volume of aquifer storage. With careful surveillance and monitoring on the part of the States, injection practices can be reduced or halted long before there would be any possible threat to public-water supplies. Also, the development of new treatment technologies or new disposal methodologies should be anticipated.

Where underground injection is deemed to be a safe procedure in terms of protecting public-water supplies, the possible adverse impact of building or installing new injection facilities can be considered as relatively minor. For the most part, installation of an injection facility requires only the construction of a vertical well (which is essentially similar to the construction of any water well).

The drilling and construction of a well is normally a routine procedure, and has taken place at tens of millions of sites across the United States without causing intolerable impacts. Construction of a well generally takes only a few days to a few weeks, depending on depth and diameter, during which a drilling machine is operated and creates minor local problems of noise and emission of engine exhaust fumes. This impact is no different from the operations of any other motor vehicle or other construction activities and should not be considered as a special adverse impact of well injection procedures.

These minor impacts during the construction and installation of underground injection facilities constitute a small price to pay in comparison with the considerably larger benefits to be derived from protecting drinking-water supplies by removal of contaminating influences from contact with man.

From a resource recovery viewpoint, the metals and other substances contained in waste fluids can be thought of as a resource that should be conserved for possible future recovery. In a sense, this is not any different from any other waste accumulation of man, such as the materials disposed of in landfills or discharged to the sea in treated sewage effluent. To date, man's technology for making better use of the resources contained in wastes has not yet progressed to the point where full utilization can be made of them. Some efforts are in progress to salvage valuable materials from disposal facilities, but some of these are prohibitively expensive and as long as the natural sources of some of these constituents are as abundant as they are, there is no economic justification for attempting full recovery of resources from these wastes. Exactly the same reasoning is applicable to the dissolved materials contained in fluids which may be injected underground.

Futhermore, as noted above, underground injection is not truly a final and ultimate method for disposing of wastes so that they are irretrievable. Quite the opposite is the case, because most injected fluids are simply being stored underground and theoretically could be removed through installation of wells and through pumping when technologies would become available to reclaim their mineral constituents. Although small amounts of the injected substances will never be recoverable, because they have become absorbed or filtered out by passage through the soils.

VI. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

It is obvious that once the Underground Injection Control Regulations are implemented, the costs that will be incurred by all levels of government to initiate and maintain them and by the injectors themselves will be irretrievable. Once these funds have been committed for the intended purposes, they can never be regained even if the UIC Program were to be terminated. Irretrievable costs of this kind would apply to the new manpower needed to implement the program, the administrative and managerial expenses, the improved construction techniques for underground injection facilities, and the new costs for inspection, surveillance, and monitoring of these facilities. Likewise, monies expended on public hearings and other negotiations that may be involved in permitting and in settling disputes also would not be recoverable.

Although, as referred to in Section V, the fluids injected underground have a potential for later recovery, the present state of the art is such that it is prohibitively expensive to make use of more than a small percentage of the injected fluids. Presently, therefore, these fluids can be thought of as irretrievable. When the natural supplies of some of these substances have been depleted, and new treatment methods and other technologies are available, it may become desirable to undertake recovery procedures, and at that time some of the injected fluids will become classifiable as retrievable resources.

Some of the substances injected could never be recovered, regardless of conceivable new technologies, because they would have been precipitated underground or would have migrated to locations or depths where subsequent withdrawal would be impossible.

Another irreversible commitment is the use of materials in the construction of underground injection facilities. Once installed, most of these materials are, for all practical purposes, not salvageable either physically or economically. For example, it is too expensive to retrieve several thousand feet of well casing which has been drilled deep into the earth and cemented in place. Because well casings have only a limited life expectancy (perhaps on the order of ten to thirty years) due to corrosion problems, it is not reasonable to envision possible future salvage and reuse of these casings after an installation has been in operation for some years. In contrast, it may be possible in some instances to rehabilitate and reuse some pumps that have only been operated for a few years, in cases where an injection facility has been shut down. This could be thought of as a possible reversible commitment of resources.

Where accidents such as spills or ruptures should occur, some irreversible damage to the environment might take place locally. This would arise if highly toxic fluids were to be released at a point close enough to present an immediate threat to a public water-supply system, and where it was impractical to attempt to pump the contaminated fluids out of the ground or to block its path of flow to the threatened public water-supply facility. Because the regulations are intended to improve surveillance and inspection, and thereby, protect water quality, they will reduce the possibilities of such accidents. It is concluded, therefore, that the net gain in protection of public health will outweigh the irreversible threat of scattered accidental contamination.

Energy used to operate injection facilities will be irretrievably lost. The gain in public health protection from disease from improved control of underground injection will far exceed the dollar costs of energy.

Several clearly irreversible benefits to be derived from the regulations will be the overall improvement in drinking water quality, the increased capability on the part of State agencies to cope with underground injection problems, and an overall improvement in land-use capability where the regulations abate or or eliminate existing contamination problems. The entire thrust of the Act is to achieve an improvement in drinking-water quality, and as long as the regulations remain in force and are properly implemented, this improvement can be thought of as irreversible. There should be a net gain in terms of public health and drinking-water quality that cannot be reversed as long as the regulatory program remains in effect.

Because the States will have to expand and improve their capabilities for coping with all types of underground injection problems, their technical staffs will have gained a permanent benefit in improved competency and experience in dealing with water contamination. With better documentation and better monitoring and surveillance, the States also will have substantially improved their ability to cope with additional aspects of environmental protection.

Because the regulations undoubtedly will abate or halt certain injection practices that now degrade surface-water bodies and other elements of the surficial environment, a continuing benefit will accrue to the residents of those areas as an outcome of implementation of the regulations. There should be a gradual improvement in the aesthetic and recreational values of some lands, which will be permanent and irreversible as long as the regulations remain in force. Also, stream quality will benefit in various places and some improvements will be noted with regard to vegetation and wildlife in areas that have been seriously degraded as an outcome of uncontrolled disposal of liquid wastes.

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APPENDIX TABLES I - IV

COLORADO DEPARTMENT OF HEALTH
Water Pollution Control Commission
4210 East 11th Avenue
Denver, Colorado 80220
Effective date: July 1, 1970

Appendix Table I.
RULES AND REGULATIONS FOR SUBSURFACE DISPOSAL SYSTEMS

Section 1. - DECLARATION OF POLICY. - These Rules and Regulations provide the conditions for the location, construction and operation of subsurface disposal systems. After the effective date of the adoption of these Rules and Regulations, no subsurface disposal system shall be constructed or operated in this State contrary to the provisions of these Rules and Regulations.

Section 2. - DEFINITIONS. - As used in these Regulations:

(a) "Act" means the Colorado Water Pollution Control Act of 1966, Chapter 66, Article 28, C.R.S. 1963 (1967 Perm. Cum. Supp.).

(b) "Aquifer" means a permeable formation which contains and transmits ground water or formation water.

(c) "Coefficient of Storage" means the volume of water released from a unit volume of the aquifer when the piezometric surface declines one (1) foot.

(d) "Commission" means the Colorado Water Pollution Control Commission.

(e) "Construction" when used with respect to a disposal system shall mean any initial creation of a new disposal system, any material modification or alteration of any existing disposal system, and the conversion of any condition or structure not previously used as a disposal system into such a system.

(f) "Disposal aquifer" is any aquifer into which wastes are intended to be disposed of by means of a disposal system.

(g) "Dispose" and "Disposal" mean the deposit, generation, creation, or discharge of any wastes at any level below the land surface.

(h) "Operate" when used with respect to a disposal system means the use or employment of that system to dispose of wastes below the surface of the land.

(i) "Person" means the state, or any agency or institution thereof, any municipality, political subdivision, public or private corporation, individual, partnership, association, or other entity, and includes any officer or governing or managing body of any municipality, political subdivision, or public or private corporation.

(j) "Pollution" means such contamination, or other alteration of the physical, chemical, or biological properties of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life.

(k) "Subsurface" means any level below the surface of the land.

(l) "Subsurface disposal system" means any system or facility, method, excavation, well structure or condition of any kind whatsoever (other than septic tank systems, solid waste disposal sites, sanitary landfills, refuse disposal sites, oil and gas wells, water injection wells employed in oil and gas well operations, surface ditches or retention ponds and irrigation and water transportation systems), used, employed or operated so that the same may reasonably be expected, by direct or indirect means, to result in the disposal of wastes underground, including without limitation, the following: Sewage systems, treatment works, wells into which wastes are deposited or injected, installations, structures, wells and excavations to be used in connection with any subsurface explosion, detonation, reaction or process that might tend to discharge, deposit or generate wastes underground, and mines or other excavations initially made for other purposes when they are used for disposal.

(m) "Subsurface water" or "Groundwater" means any waters of the State not visible on the surface of the ground under natural conditions.

(n) "System" means all surface and subsurface equipment, installations and appurtenances and shall include the formations within the zone of influence of a subsurface disposal system.

(o) "Waste" means any substance, solid, liquid or gaseous, including radioactive particles thereof, which pollute or may tend to pollute any waters of the State.

(p) "Workover" means any remedial procedure which could change the physical or chemical characteristics of the formation, or changes in physical equipment (other than routine maintenance of mechanical equipment), changes in method of injection (acidizing, artificial fracturing), repairing or replacing casings, tubing, packing and plugging or perforating additional zones.

(q) "Zone of influence" means the areal extent to which a waste can or will migrate or be dispersed within a stated period of time from a subsurface disposal system, as well as the areal extent of the significant variations of formation fluids caused by such a system.

Section 3. - PREREQUISITES TO CONSTRUCTION AND OPERATION OF SUBSURFACE DISPOSAL SYSTEMS.

(a) No person shall construct or operate a subsurface disposal system within the State of Colorado unless such person has a currently effective permit for such construction or operation issued by the Commission pursuant to this Section.

(b) No person shall receive a permit from the Commission for the construction or operation of a subsurface disposal system within the State of Colorado unless the Commission, acting upon the application of a person proposing to construct or operate a subsurface disposal system shall have found and determined beyond a reasonable doubt with respect to the proposed subsurface disposal system, after notice and public hearing, one of the following:

(1) that no waters of the State will be adversely affected thereby; or

(2) that if waters of the State may be adversely affected thereby, it is reasonably certain such waters have then no present or foreseeably beneficial use and there is no reasonable probability such waters, if adversely affected, will mingle with or be tributary to beneficially usable waters of the State; or

(3) that if the waters of the State affected by the proposed system may mingle with or be tributary to beneficially usable waters, that the proposed system provides for such protective measures or plan of treatment as will adequately preserve with reasonable certainty, the beneficial uses and prevent the pollution of such waters; or

(4) that if any beneficially usable waters of the State may be polluted by the operation of the proposed system, that there is no risk of significant migration of such waters and that the proposed activity is justified by public need.

Any other finding by the Commission shall preclude the construction or operation of a subsurface disposal system at the site proposed in the application in response to which the Commission has made its findings.

(c) Every finding by the Commission under the provisions of subparagraph (b) of this Section shall be stated in writing, refer to the application upon which it was based, and shall be final; provided, however, the Commission will grant a rehearing to an applicant requesting the same if good cause therefore be shown to the Commission and such request is made within 30 days after the date of the entry of the Commission's findings. When information or data other than that contained in an application is considered by the Commission in making its finding, the applicant or any interested person shall have a right, upon request, to be informed of the nature and source of such information or data. Any person assuming to construct and/or operate a subsurface disposal system, with or without a permit issued by the Commission, shall be solely responsible for such system and shall be deemed to have assumed all risks in respect to the construction and operation of such system.

(d) When the Commission shall have, pursuant to application, made one of the findings described in subparagraphs (1) - (4) of subsection (b) of this Section, the Commission shall grant to the applicant a permit to construct, operate or construct and operate, as the case may be, the subsurface disposal system for which the application has been made, which permit may be subject to any conditions reasonably required by the Commission.

(e) Any person having applied to and received from the Commission a permit under the provisions of this Section and thereafter assuming to construct and/or operate a subsurface disposal system under that permit shall be subject always to such orders and regulations as the Commission may reasonably require, from time to time, for the prevention, abatement and control of pollution to the waters of the State, including but not limited to one or more of the following:

(1) that no zone or interval, other than the zone or interval represented to the Commission as the disposal interval or aquifer, shall be used as part of the system except after notice and hearing.

(2) that a monitoring system, including prescribed equipment, tests, and installations, shall be provided and operated at the sole risk, cost and

expense of the persons interested in the system; provided, however, the Commission may designate some third party to utilize the monitoring system data developed by or for the operation of the system.

(3) that treatment of wastes shall be provided to that degree required by the Commission.

(4) that workover or remedial procedures shall not be performed without prior notification to the Commission and then only to the extent ordered by the Commission.

(5) that disposal shall be only in such manner as may be ordered by the Commission in respect to volume, rate, pressure, and similar parameters and shall not exceed that specified or be of a kind different from that presented to the Commission upon the application filed under the provisions of Section 4 of these Rules and Regulations.

(6) that all drilling, completing, and operating procedures for subsurface disposal and monitoring systems or wells shall conform to those practices and procedures previously reviewed by the Commission and that any deviation in procedure or equipment from that specified in the applications presented to the Commission shall require the concurrence of the Commission before deviation from such procedures may be implemented.

(7) that an adequate back-up facility be provided, including surface equipment, pumps, well-head, transmission lines, holding tanks, retention ponds and treatment facilities, to assure that a system may be safely shut down in the event of component failure and to assure the treatment of effluent to a suitable degree for temporary surface disposal.

(8) that evidence of financial responsibility be submitted to the Commission and, when the Commission so requires by its order, security, in the form of cash, approved securities, surety bond, or evidence of insurance, be deposited with the Treasurer of the State of Colorado, in such amount and with and under such conditions as the Commission may direct to assure the people of the State of Colorado of the continued compliance with the Commission's orders and that, upon abandonment, cessation or interruption of the construction or operation of the system, appropriate measures will be taken to prevent present or future pollution of the beneficially usable waters of the State. Whenever evidence of financial responsibility is required, such evidence shall be furnished annually for as long as the Commission may require.

(9) that the Commission shall be furnished with such reports, charts, forms, and other information as it may reasonably require and at such intervals as may be directed by the Commission from time to time.

(10) that notwithstanding any prior finding, order or permit of the Commission, the continued or future construction or operation or use of a disposal system shall, upon order of the Commission, be discontinued after notice and hearing if the Commission determines that continued operation thereof is or may tend to be injurious to the then present or foreseeably beneficially usable waters of the State.

Failure to comply with any condition or order of the Commission in respect to any disposal system, or any action required to be taken in respect thereto, shall be cause for the Commission to order the suspension or termination of construction or operation of such system, and the suspension or revocation of any permit issued pursuant to this Section.

Section 4. - APPLICATION FILED WITH COMMISSION. - Any person proposing to construct or operate, or cause to be constructed or operated, a subsurface disposal system within the State of Colorado shall file with the Commission a verified, written application for a permit under Section 3 of these Rules and Regulations. Such application shall contain, unless the requirement is waived as inapplicable by an order of the Commission, the following:

(a) A legal description of the area within a radius of two (2) miles of the proposed system and a legal description of the site upon which the system will be located.

(b) An accurate map of the area within a two (2) mile radius of the proposed system showing the location of the system, property boundaries, surface and mineral ownership of record, the location of all water wells and oil and gas wells and whether the same are operating or have been abandoned and, if appropriate, whether such wells have been plugged; and the location of all mines, test holes and other artificial penetrations or excavations.

(c) A description of the depths and deepest formations penetrated by each of the wells, mines, excavations or penetrations required to be shown on the map required at (b) above.

(d) A description of local topography, industry, agriculture, population densities, culture, wildlife, and fish and other aquatic life within the area of the proposed system with a projection as to the probable effect of the system upon industry, agriculture, population, culture, wildlife, and fish and other aquatic life.

(e) A description of the mineral resources believed to be present in the area of the system and the probable effect of the system upon such mineral resources, together with a map or maps illustrating geologic structures and stratigraphic sections (formations, lithologies and physical characteristics for the local area and a general map illustrating the regional geologic setting of the system). Such exhibits shall be prepared by a qualified expert.

(f) A description of all water resources, both surface and subsurface, within the probable zone of influence of the system, the classification if any, the available amounts thereof and potential uses and a map or maps indicating vertical and lateral limits of surface and subsurface water supplies.

(g) A description of the chemical, physical, radiological, and biological properties and characteristics of the wastes to be disposed of through the system, and the treatment proposed for such wastes.

(h) Copies of all plans and specifications for the system and its appurtenances.

(i) A statement of all sources relied upon for the information set forth in the application.

(j) If the disposal system is to be an injection well, and if requested by the Commission in the case of any application, the following information may be required:

(1) Potentiometric surface maps of the disposal aquifers and those aquifers immediately above and below the disposal aquifer.

(2) Copies of all drill-stem tests, extrapolations and data used in making the maps required at (1) above.

(3) Location and nature of present and potential use of fluids from the disposal or affected aquifer formations in the general area.

(4) Volume, rate and injection pressure of the fluid to be injected.

(5) The following geologic and physical characteristics of the injection interval and the overlying and underlying impermeable barriers:

(aa) Thickness.

(bb) Areal Extent.

(cc) Lithology (grain mineralogy, type and mineralogy of matrix, amount and type of cement, clay content, clay mineralogy).

(dd) Effective porosity and how determined.

(ee) Permeability, vertical and horizontal, and how determined, i.e., mechanical (electrical) logs, core analyses, formation tests.

(ff) Coefficient of storage of aquifer.

(gg) Amount and extent of natural fracturing.

(hh) Location, extent and effects of known or suspected faulting.

(ii) Extent and effects of natural solution channels.

(jj) Fluid saturation.

(kk) Formation fluid chemistry with indications of local and regional variations.

(ll) Temperature of formation and how determined.

(mm) Formation and fluid pressures, original and modifications resulting from previous fluid withdrawals.

(nn) Fracturing gradients.

(oo) Osmotic characteristics of rock and fluids both comprising and contiguous to the reservoir, and an indication of the effect of injected wastes on contiguous formations in the event of leakage.

(pp) Diffusion and dispersion characteristics of the waste and formation fluid, including effect of gravity segregation.

(qq) Compatibility of injected waste with physical, chemical and biological characteristics of the reservoir.

(6) The following engineering data concerning the well:

(aa) Size of hole and estimated total depth of well.

(bb) Type, size, weight, strength, and related data in respect to all surface, intermediate and production casing.

(cc) Specifications and proposed installation of tubing and packers.

(dd) Proposed cementing procedures and type of cement.

(ee) Proposed coring program.

(ff) Proposed information testing program.

(gg) Proposed injection procedure, i.e., open hole, perforated casing.

(7) Plans for monitoring the system and, if the system is a deep disposal well, the plans for monitoring injection pressures and formation pressures, i.e., injection wells and observation wells.

(8) Expected changes in pressure, rate of fluid displacement by injected wastes, directions of dispersion and area affected by the system.

(k) Such other and further data as the Commission may reasonably request. An applicant may upon its own initiative, and when requested by the Commission, an applicant shall furnish an opinion of independent experts, satisfactory to the Commission, in respect to the accuracy and completeness of any information or data furnished by the applicant and on any aspect of the applicant's disposal system or the contemplated operation or effects thereof.

Section 5. - PRELIMINARY REVIEW OF APPLICATIONS

(a) The Commission recognizes that the accumulation of the information and data required to complete an application under Section 4 of these Rules and Regulations may involve considerable expense to an applicant. Therefore, and merely as a convenience to applicants, the Commission will accept for preliminary review applications setting forth in general terms the information specified in Section 4, but the same shall be set out in sufficient detail so as to enable the Commission to determine the general feasibility of a proposed system. Such applications shall be clearly designated as "for preliminary review" under authority of this Section.

(b) The Commission may rule upon applications submitted for preliminary review and either approve or disapprove the feasibility of the proposed system. The approval or disapproval by the Commission upon preliminary review of applications shall in no way affect the right of an applicant to subsequently submit an application or applications containing the data required by Section 4 of these Rules and Regulations. The Commission shall not be bound by its ruling upon any application submitted for preliminary review.

Section 6. - PROCEEDINGS BEFORE THE COMMISSION - NOTICE - PUBLIC HEARING.

(a) Before any finding upon an application, or application for rehearing, or order, or amendment of an order shall be made by the Commission under these Regulations, there shall be held a public hearing upon at least twenty (20) days notice at such time and place as may be prescribed by the Commission and any person interested in the action of the Commission shall be entitled to appear and be heard; except, when an emergency requiring immediate action is found to exist by the Commission, the Commission may issue an emergency order without notification of the hearing, which shall be effective upon promulgation, but shall remain effective for no more than twenty (20) days.

(b) The Commission shall cause notice of every public hearing to be given by personal service to each surface and mineral owner of record within a two (2) mile radius of any subsurface disposal system which may be the subject of any proceeding before the Commission, or it may give such notice by one publication in a newspaper of general circulation in the City and County of Denver, Denver, Colorado, and in a newspaper of general circulation in the County where the land affected by a subsurface disposal system, or some part thereof, is situated. Said notice shall be issued in the name of the State of Colorado, shall be signed by the Commission, or the Technical Secretary of the Commission, and shall specify the style and number of the proceedings, the time and place of the hearing, and shall briefly state the purpose of the proceeding.

(c) If notice is given by personal service, such service shall be made by an officer appointed to serve summons, or by an agent of the Commission, in the same manner and extent as is provided by law for the service of summons in civil actions in the District Courts of this State. Proof of service by such agent shall be by his affidavit and proof of service by any officer shall be in the form required by law with respect to service of summons in civil actions.

(d) In addition to the notice required to be given by the Commission under subparagraph (b) of this Section, notice of every application filed with the Commission shall be given by the applicant by mailing or delivering a copy of the application to each surface and mineral owner of record within two (2) miles of any proposed subsurface disposal system. Such notice shall be mailed or delivered on or before the date the application is filed with the Commission. An affidavit shall be attached to the application showing the parties to whom the notice required by this subsection has been served, and their respective addresses.

(e) The Commission shall designate a hearing officer, as provided in the Act, who shall make findings and recommendations to the Commission in respect to any matter pertaining to a subsurface disposal system.

(f) The Commission may, on its own motion, or upon the request of any interested person, institute a proceeding to prevent a violation of the Act, or of any order, rule or regulation of the Commission relating to a subsurface disposal system, or for the amendment of any order, rule or regulation, by notice of hearing, or issuance of an emergency order to show cause directed to and served upon any person or persons charged with violating the same.

(g) Hearings before the Commission shall be conducted without rigid formality. A transcript of testimony shall be taken and preserved as part of the permanent record of the Commission. Any person testifying before the Commission or in support of an application or in opposition thereto shall be required to do so under oath or affirmation. Full opportunity shall be afforded all interested parties at a hearing to present evidence and to cross-examine witnesses. In general, the rules of evidence applicable before a trial court without a jury shall be applicable, providing that such rules maybe relaxed, where by so doing, the ends of justice will be better served.

Section 7. - TERMINATION, ABANDONMENT - No subsurface disposal system subject to these Regulations shall be terminated or plugged and abandoned except after notice and hearing. Every plugging and abandonment shall be accomplished in accordance with the orders of the Commission. Monitoring equipment shall be operated after termination or abandonment for as long as the Commission may reasonably require, which operation shall be at the sole risk, cost, and expense of the person responsible for the disposal system.

Section 8. - WAIVER OF BASIC STANDARDS. - Any person operating a subsurface disposal system under an effective permit issued pursuant to these Rules and Regulations shall not, as a result of the discharge from that system, be deemed to be in violation of the Basic Standards applicable to all the waters of this State.

Section 9. - RELEASE OF SECURITY. - When any person constructing or operating a disposal system has been required by the Commission to make a security deposit and when that person can affirmatively demonstrate to the Commission that said disposal system has been finally terminated and all reasonable measures have been taken to protect the waters of the State from pollution, the Commission shall, by order, direct the Treasurer of the State of Colorado to release such security deposit.

Section 10. - OTHER REGULATORY AGENCIES. - Nothing in these Regulations shall relieve a person making application to the Commission from complying with all applicable rules and regulations of other government agencies, whether State of Federal.

Section 11. - RESPONSIBILITY. - Compliance with the Rules and Regulations contained herein shall in no way be deemed to relieve any person of any liability, obligation or duty imposed on such person by statute or the common law.

Section 12. - RELIANCE UPON OTHER AGENCIES. - The Commission and the Division of Administration shall freely consult with such other state and Federal agencies and departments, including the Colorado State Planning Office, as it or the Division of Administration of the Commission may deem necessary for a proper determination of any matter subject to these Regulations. Notice of hearing before the Commission or before a hearing officer designated by the Commission shall be given to interested State and Federal agencies and departments.

Appendix Table II. - Policy Statement of ORSANCO on Underground Injection

RESOLUTION NO. 1-73
Policy on the Underground Injection of Wastewaters
Adopted: January 11, 1973

WHEREAS: Underground injection is a technically acceptable method of wastewater disposal of long-term storage whereby pollutants can be removed from the surface environment and placed in isolated underground locations; and

WHEREAS: The techniques, trained personnel and organizations are available within the ORSANCO district for evaluation of the geologic and engineering feasibility of underground disposal and for determination of the risks, if any, that may exist to public health and to the environment;

NOW, THEREFORE: Let it be resolved that the Ohio River Valley Sanitation Commission does declare as a policy that wastewater injection may be used when the regulatory authorities with legal jurisdiction have considered other alternative methods of waste management, and that, after weighing all available evidence, have determined that:

I. Underground injection is the best available alternative in the specific circumstances of the case;

II. Geologic and hydrologic conditions will, beyond a reasonable doubt, provide adequate protection of the public and natural resources;

III. The volume, chemical and physical composition, and toxicity of the fluid to be injected are compatible with the geologic and hydrologic conditions;

IV. The necessary safety factors and monitoring devices are incorporated in the design of the injection well and its auxiliary facilities;

V. The waste injection system will be operated in a manner compatible with the geologic conditions, waste character, and system construction;

VI. An approved alternative plan for waste management is available in the event that operational problems occur during the use of the injection system;

VII. The injection well will be properly plugged and marked before abandonment;

VIII. A permanent public record will be kept which documents the complete operational history of the injection system.

Appendix Table III. -- STATE AGENCIES REGULATING BRINE DISPOSAL

(American Petroleum Institute, 1975)

		Method of Disposal		Legal Basis & Procedures						
State	Regulating Agency	Injection Well	Pits and Basins	Acts or Laws	Statutes	Rules or Regulations	Permits	Public Hearings	Coordinating Agencies	Remarks
Alabama	State Oil & Gas Bd.	x	x	x			x	x	Water Improvement Comm.	
Alaska	Oil & Gas Conserv. Commission	x	x			x	x		Dept. of Health & Welfare; Dept. of Environmental Conservation	
	Dept. of Nat. Resources				x	x				
Arizona	Oil & Gas Conserv. Commission	x	x			x	x		Dept. of Health	
Arkansas	Oil & Gas Comm.	x	x			x	x		State Geol. Survey; Dept. of Health; Dept. of Poll.Control & Ecology	
California	Div. of Oil & Gas--Dept. of Conserv.	x	x	x			x		State Water Resources Board	Discharge to ocean permitted
Colorado	Oil & Gas Conserv. Commission	x	x			x	x		Division of Game; Water Pollution Control Comm.; Div. of Water Resources; Geological Survey	
Connecticut	None									
Delaware	None									
Florida	Dept. of Environmental Regulation	x				x	x		Dept. of Natural Resources	
Idaho	None									
Illinois	Div. of Oil & Gas; Dept. of Mines and Minerals	x	x	x		x	x		Mining Board	

Appendix
TABLE III. (Continued)

State	Regulating Agency	Method of Disposal: Injection Well	Method of Disposal: Pits and Basins	Legal Basis & Procedures: Acts or Laws	Legal Basis & Procedures: Statutes	Legal Basis & Procedures: Rules or Regulations	Legal Basis & Procedures: Permits	Legal Basis & Procedures: Public Hearings	Coordinating Agencies	Remarks
Indiana	Div. of Oil & Gas; Dept. of Nat. Resources	x	x		x	x	x		Board of Health- Water Pollution Control; Industrial Waste Section; Geological Survey	
Iowa	Natural Resources Council								No production; Under State Code	
Kansas	State Corp. Comm.	x	x			x	x		Dept. of Health; Geological Survey	
Kentucky	Dept. of Mines	x	x			x	x		Water Pollution Control Comm.; Dept. of Fish and Wildlife	
Louisiana	Geological Survey; Dept. of Conserv.	x	x			x	x			Discharge to tidal waters unfit for agricultural or human consumption
Maine	Mining Bureau			x						
Maryland	Geological Survey					x			Dept. of Water Resources	No specific rules for brine disposal
Massachusetts	None									No production
Michigan	Oil & Gas Section-Dept. of Natural Resources	x				x	x		None	

Appendix
TABLE III. (Continued)

State	Regulating Agency	Method of Disposal: Injection Well	Method of Disposal: Pits and Basins	Legal Basis & Procedures: Acts or Laws	Legal Basis & Procedures: Statutes	Legal Basis & Procedures: Rules or Regulations	Legal Basis & Procedures: Permits	Legal Basis & Procedures: Public Hearings	Coordinating Agencies	Remarks
Minnesota	None									No production
Mississippi	Oil & Gas Board	x	x		x	x	x		Air & Pollution Control Comm.; Bd. of Water Commissioners	Discharge to surface water, if not prohibited by other agencies
Missouri	Oil & Gas Council	x				x	x		Geological Survey and Water Resources; Div. of Commerce & Indus. Dev.; Public Service Comm.; Water Pollution Bd.; Univ. of Missouri	State Geologist is Administrator of Oil & Gas Council
Montana	Oil & Gas Conserv. Commission	x	x			x	x		Dept. of Health; Water Resources Board	
New Hampshire	None									No production
New Jersey	None									No production
New Mexico	Oil Conserv. Comm.	x	x			x	x		Water Quality Comm.--heads of Oil Conserv. Comm., Dept. of Health, Dept. of Game & Fish, Dept. of Agriculture	U.S. Geological Survey consulted if on Indian lands

Appendix
TABLE III. (Continued)

State	Regulating Agency	Method of Disposal		Legal Basis & Procedures					Coordinating Agencies	Remarks
		Injection Well	Pits and Basins	Acts or Laws	Statutes	Rules or Regulations	Permits	Public Hearings		
New York	Div. of Mineral Resources--Dept. Environmental Conserv.	x	x			x	x		Div. of Quality Services; Div. of Pure Waters	
Nevada	Oil & Gas Conserv. Commission	x	x			x	x		None	
Nebraska	Oil & Gas Conserv. Commission	x				x	x		Dept. of Health; Geological Survey	
North Carolina	None									No production
North Dakota	Industrial Comm.	x	x			x	x		None	
Ohio	Dept. of Natural Resources	x	x			x	x		None	
Oklahoma	Oil Corp. Comm.	x				x	x		Dept. of Pollution Control	
Oregon	Dept. of Geology and Mineral Resources	x	x	x		x			Dept. of Environmental Quality	No production; no permits issued
Pennsylvania	Div. of Oil & Gas--Dept. of Mines & Mineral Industries		x	x			x		Sanitary Water Bd.--Dept. of Health	Provides for settling basins and dumps
Rhode Island	None									No production
South Carolina	None									No production

Appendix
TABLE III. (Continued

States	Regulating Agencies	Method of Disposal		Legal Basis & Procedures					Coordinating Agencies	Remarks
		Injection Well	Pits and Basins	Acts or Laws	Statutes	Rules or Regulations	Permits	Public Hearings		
South Dakota	Oil & Gas Board		x			x	x		Dept. of Health	Injector also needs permit from Dept. of Health
Tennessee	Oil & Gas Board					x	x		Dept. of Health	No disposal to date
Texas	Div. of Oil & Gas; Railroad Comm.	x				x	x	x	Water Quality Bd.; Water Develop. Bd.; Dept. of Parks & Wildlife; Dept. of Health	No pits allowed; discharge offshore allowed
Utah	Div. of Oil & Gas--Dept. of Nat. Resources	x	x	x		x			Water Pollution Comm; U.S. Geological Survey	
Vermont	None									No production
Virginia	Dept. of Labor & Industry			x					Water Control Board	No rules or regulations for brine disposal
Washington	Oil & Gas Conserv. Comm.; Div. of Mines and Geology					x				No provisions for brine disposal
West Virginia	Oil & Gas Div., Dept. of Mines	x				x	x		Dept. of Natural Resources	

Appendix
TABLE III. (Continued)

State	Regulating Agency	Method of Disposal		Legal Basis & Procedures					Coordinating Agencies	Remarks
		Injection Well	Pits and Basins	Acts or Laws	Statutes	Rules or Regulations	Permits	Public Hearings		
Wisconsin	None									No production
Wyoming	Oil & Gas Conserv. Commission	x	x			x	x		Dept. of Health; Fish and Game Commission	

Appendix Table IV.

ILLINOIS
OUTLINE OF STATUTORY AUTHORITY AND REGULATIONS RELATING TO POLLUTION CONTROL AND WASTE DISPOSAL
(American Petroleum Institute, 1975)

I. WATER

A. Statutory Authority.

Water pollution control law comes from the Illinois Environmental Protection Act of 1970 and from an Act In Relation to Oil, Gas, Coal, and Other Surface and Underground Resources, effective July 20, 1941 and as amended. The agencies responsible for promulgating rules and regulations and enforcing pollution control are:

1) Illinois Pollution Control Board - established by the Environmental Protection Act to determine, define, and implement the environmental control standards applicable in the State of Illinois and to conduct hearings upon complaints charging violations and petitions for variances.

2) Illinois Environmental Protection Agency - established by the Environmental Protection Act to collect and disseminate information, conduct experiments, conduct a program of surveillance and inspection of actual or potential contaminate sources, investigate violations of the Act or regulations, present enforcement cases before the Pollution Control Board, and recommend pollution control regulations to the Board.

3) Division of Oil and Gas, Illinois Department of Mines and Minerals - has jurisdiction and authority over oil and gas operations as evidenced by Section 45(a) of the Environmental Protection Act, except that water quality standards set forth by the Board apply to and are effective within the areas covered by the Department of Mines and Minerals. If the Department of Mines and Minerals fails to act upon a complaint within 10 working days following receipt of the complaint, the Illinois Environmental Protection Agency may proceed under the provisions of the Environmental Protection Act.

B. Rules and Regulations.

Division of Oil and Gas, Illinois Department of Mines and Minerals.

Rule II, Permits.

(3) Requires application for permit to drill a geological or structural test hole or water supply well.
(4) Requires permit for drilling, deepening, or converting any well for injecting gas, air, water, or other liquids into any underground formation.

Rule VII, Waste Prohibited.

(1) Waste gas must be flared.
(2) Prohibits escape of unburned gas. Surplus gas must be burned at a safe distance.
(3) Burn-off pits must be at a safe distance and must be burned as often as necessary to prevent overflowing. Such pits shall have a continuous wall sufficient to prevent escape of oil or water drainage into the pit.

Appendix Table IV. (Continued)

Earthen pits are permitted where the soil is heavy and tight, but are prohibited where soil is porous and closely underlain by sand or gravel.

Rule VIII, Protection of Workable Coal Beds.

(1) Defines workable coal beds and requires that such beds be protected from penetrating wells.

(6) Requirements for operating over an active mine.

B. Drilling methods and procedures.

(2) Requires a mine protective string of casing be set in wells penetrating active mines.

(3) Requires specified casing diameter, centralizers, and cementing of the oil string in wells drilled in active mines.

Rule IX, Avoidance of Fresh Water Pollution and Disposal of Salt Water or Other Liquids to Prevent Waste as Defined in the Act.

To assure fresh water supplies and prevent waste, no person shall dispose of salt water or other liquid wastes except as follows:

(1) Disposal in Underground Stratum.

Mining Board must issue permit, has authority to designate and approve the stratum into which liquids are disposed, and has authority to prescribe the protective work necessary to confine such liquids to the intended stratum.

(2) Disposal in Earthen Pits.

A. New Pits - Application must be made to the Mining Board for permit. Geological and engineering data may be requested. Earthen pit can be constructed only when proposed pit area is underlain by tight soil such as clay or hardpan to prevent seepage.

B. Existing Pits - Application must be made to the Mining Board for permit. All pits shall have continuous surrounding walls to prevent surface drainage entering. Pits shall not be used in areas subject to flooding unless constructed so as to normally not be affected by flooding.

(3) Pipes to be kept in repair.

(4) Slush and Mud Pits.

One slush pit required for cable tool drilling. For rotary drilling a mud circulation pit and reserve pit are required.

(5) Rotary Drilling Procedure.

Sufficient surface casing shall be run to reach a depth below all utilized fresh water zones and such casing shall be cemented by the displacement method with sufficient cement to circulate to the top of the hole. In lieu of surface casing requirements, the flow string may be cemented by displacement with sufficient cement to protect all utilized fresh water strata.

(6) Cable Tool Drilling Procedure.

Sufficient surface casing shall be set to protect all utilized fresh water zones and shall be cemented by displacement.

(7) Mining Board Supervision.

Improper inpoundment of disposal of salt water or other liquid waste or pollution of utilized fresh water stratum shall be corrected by order of the Mining Board.

(8) Annual Inspection of Pits.

All pits for which permits have been issued shall be subject to a yearly inspection by the Mining Board. Ten days after written notice to the operator and after a hearing, pit may be condemned by the Board.

Appendix Table IV. (Continued)

Rule XI, Plugging of Wells.
To prevent waste, nonproductive wells drilled for oil or gas, unused input wells, unused salt water disposal wells, and unused geological or structure test holes drilled below the glacial drift shall be securely plugged and abandoned.

(2) Well to be plugged when:
  a. Drilling operations shall have ceased for 30 days and no production string has been run.
  b. Any well for which operations have ceased for six months.

(3) Prior Notice to Mining Board.
Mining Board representative should be notified at least eight hours in advance of plugging operations or pulling of casing.

(5) Plugging Methods and Procedures.
Oil, gas, coal, and fresh water formations should be protected through properly placed cement plugs at specified depths and mud-laden fluid.

(6) Converting to Water Well.
A well can be used for fresh water purposes if approved by the Mining Board and properly plugged below the fresh water stratum.

Rule XI-A, Sealing of Abandoned Water Wells.
Unsealed abandoned water wells must be sealed with types and amounts of materials designated to prevent intermingling of desirable and undesirable waters.

Illinois Pollution Control Board--Part II. Water Qualtiy Standards.

Rule 203, General Standards.
In order to protect the State's water for aquatic life, agricultural use, primary and secondary contact use, and most industrial uses, and to ensure the aesthetic quality of the State's aquatic environment, the following water quality standards apply:

(a) Freedom from unnatural sludge or bottom deposits, floating debris, visible oil, odor, unnatural plant or algae growth, unnatural color or turbidity, or matter in concentrations or combinations toxic or harmful to human, plant, animal, or aquatic life.

(b) pH (Storet number-00400) shall be within the range 6.5 - 9.0.

(e) Radioactivity
  1. Gross beta (Storet 4-03501) concentration shall not exceed 100 pica curies per liter.
  2. Concentration of radium 226 (Storet number-09501) and strontium 90 (Storet number-13501) shall not exceed 1 and 2 pica curies per liter, respectively.

(f) The following levels of chemical constituents shall not be exceeded.

	Storet No.	Concentration (mg/L)
Barium	01005	5.0
Chloride	00904	500.0
Iron (total)	01046	1.0
Phenals	32730	0.1
Sulfate	00945	500.0
Total Dissolved Solids	00515	1000.0

(h) Any substance toxic to aquatic life shall not exceed one-tenth (1/10) of the 48-hour median tolerance limit (48TLm) for native fish or essential fish food organisms.

Appendix
Table IV.
(Continued)

REGULATIONS OF STATE OF ILLINOIS
RELATING TO POLLUTION CONTROL AND WASTE DISPOSAL

OPERATION	ILLINOIS DEPARTMENT OF MINES & MINERALS DIV. OF OIL & GAS Rules having state-wide application to oil & gas operations	ILLINOIS POLLUTION CONTROL BOARD			
		WATER QUALITY	AIR QUALITY	SOLIDS WASTE MANAGEMENT	
I. EXPLORATION					
a. Geophysical					
b. Shot Holes	Rule II (3)		Rules 202, 203		
c. Core Drill Holes	Rule II (3)				
d. Drilling Fluid Pits		Rules 203, 403, 601		Rules 106(b),(c)	
e. Cuttings				Rules 106(b),(c)	
f. Rights-of-way Clearing & Restoration			Rules 502,504(a)4	Rules 106(b),(c)	
g. Fresh & Salt Water Protection		Rules 203, 403, 601			
h. Proper Abandonment				Rules 106(b),(c)	
i. Sanitation Camp Regulations			Rules 502,503(b)	Rules 106(b),(c), 201, 203, 222	
j. Oil Spills		Rule 601(b)			

Appendix
Table IV.
(Continued)

REGULATIONS OF STATE OF ILLINOIS
RELATING TO POLLUTION CONTROL AND WASTE DISPOSAL

OPERATION	ILLINOIS DEPARTMENT OF MINES & MINERALS DIV. OF OIL & GAS Rules having state-wide application to oil & gas operations	ILLINOIS POLLUTION CONTROL BOARD			
		WATER QUALITY	AIR QUALITY	SOLIDS WASTE MANAGEMENT	
II. DRILLING					
a. Location and Rights-of-Way			Rules 502,504(a)4	Rule 106(b),(c)	
b. Drilling Fluids Pits	Rule IX (4)	Rules 203, 403, 601		Rule 106(b),(c)	
c. Cuttings				Rule 106(b),(c)	
d. Drilling Fluids -- all types			Rule 502		
e. Fresh & Salt Water Protection	Rules IX(5),(6), (7), XI(6)	Rules 203, 403, 601			
f. Mineral Deposit Protection	Rules VIII (1),(6)B (2), (6)B(3)				
g. Proper Abandonment	Rules XI, XI-A		Rule 502	Rule 106(b),(c)	
h. Camps & Sanitation			Rules 502,503(b)	Rule 106(b),(c)	
i. Solids Waste Disposal			Rules 502, 504(a)4	Rules 106(b),(c) 201, 203, 222	
j. Gas Venting	Rules VII (1), (2)		Rules 202,205(g), 502,503,504(d)5		
k. Particle Control			Rule 203	Rule 106(b),(c)	
l. Noise Control					
m. Oil Spills		Rule 601 (b)			

Appendix
Table IV.
(Continued)

REGULATIONS OF STATE OF ILLINOIS
RELATING TO POLLUTION CONTROL AND WASTE DISPOSAL

OPERATION	ILLINOIS DEPARTMENT OF MINES & MINERALS, DIV. OF OIL & GAS Rules having state-wide application to oil & gas operations	ILLINOIS POLLUTION CONTROL BOARD			
		WATER QUALITY	AIR QUALITY	SOLIDS WASTE MANAGEMENT	
III. PRODUCTION					
a. Produced Water Disposal	Rules II(4),IX(1),(2), (7)	Rules 203,403,601			
b. Solids Disposal			Rules 502,504(a)4	Rules 106(b),(c), 201, 203, 222	
c. Location, Rights-of-Way			Rules 502,504(a)4	Rules 106(b),(c)	
d. Pits (workover)	Rule IX(7),(8)	Rules 203,403,601			
e. Workover Fluids			Rule 502		
f. Gas Venting	Rules VII(1),(2)		Rules 202,205(g), 502,503,504(d)5		
g. Fresh & Salt Water Protection	Rules IX(1),(2),(5), (6),(7),XI(6)	Rules 203,403,601			
h. Proper Abandonment	Rules XI,XI-A		Rules 502,504(a)4	Rules 106(b),(c)	
i. Thermal Pollution		Rule 203(i)			
j. Noise Control					
k. Sour Gas Handling			Rules 202,204, 205(g)		
l. Aesthetic Scenery Protection				Rules 106(b),(c)	
m. Field Trucking & Barging			Rules 205(a), (b), (d)		
n. Surface & Subsurface Storage					
o. Flow Control Equipment			Rule 205(g)		
p. Inland Water Crossings					
q. Oil Spills		Rule 601(b)			

Appendix
Table IV.
(Continued)

REGULATIONS OF STATE OF ILLINOIS
RELATING TO POLLUTION CONTROL AND WASTE DISPOSAL

OPERATION	ILLINOIS DEPARTMENT OF MINES & MINERALS DIV. OF OIL & GAS Rules having state-wide application to oil & gas operations	ILLINOIS POLLUTION CONTROL BOARD			
		WATER QUALITY	AIR QUALITY	SOLIDS WASTE MANAGEMENT	
IV. PLANTS					
a. Gas Venting	Rule VII(1)		Rules 202,205(g), 502,503,504(d)5	Rules 106(b),(c), 201,203,222	
b. Liquid Wastes	Rules II(4),VI(3)	Rules 203,403,601			
c. Solid Products					
d. Fresh & Salt Water Protectio	Rules IX(1),(2),(5), (6),(7),XI(6)	Rules 203,403,601			
e. Noise Control					
f. Housekeeping			Rules 502,503(b), 504(a)4		
g. Rights-of-Way			Rule 504(a)4	Rule 106(b),(c)	
h. Aesthetic Scenery Protection					
i. Start-up Operations			Rules 105,202,203, 204		
j. Surface Pits	Rule IX(2),(8)	Rules 203,403,601	Rule 502	Rule 106(b),(c)	
k. Surface & Subsurface Product Storage					
l. Product Storage & Transfer			Rule 205(a),(b), (d),(g)		
m. Oil Spills			Rules 502,504(d)5		

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
(40 CFR Part 146)
State Underground Injection Control Program
Proposed Regulations

ENVIRONMENTAL PROTECTION AGENCY
(40 CFR Part 146)
STATE UNDERGROUND INJECTION CONTROL PROGRAMS

Proposed Regulations

Introduction

Notice is hereby given that pursuant to Sections 1421, 1422, 1423 and 1450 of the Public Health Service Act, as amended by the Safe Drinking Water Act ("SDWA" or "the Act," Pub. L. 93-523), the Administrator of the Environmental Protection Agency (EPA) proposes to issue a new 40 CFR Part 146 setting forth regulations governing State underground injection control programs.

Approximately 100 million Americans are dependent upon drinking water from underground sources which have historically been relatively free from harmful contaminants. However, in recent years there has been increasing concern over the threat to public health posed by the underground injection of substances which degrade the quality of underground drinking water sources. As a result of this concern, Congress included in the Safe Drinking Water Act, enacted on December 16, 1974, a statutory mandate for the establishment of minimum requirements for effective State programs designed to protect underground drinking water sources from subsurface injection of contaminants.

The intent of the proposed regulations is to establish minimum requirements for effective State programs to protect existing and potential underground sources of drinking water from endangerment from underground injection of fluids.

It is clear from the Act and the legislative history of the SDWA that Congress intended that the States exercise primary enforcement responsibility for the protection of underground sources of drinking water to the extent possible. For this reason the regulations are designed to be administratively compatible with and non-duplicative of existing State programs. The regulations are intended to broaden and strengthen these existing State programs as well as to establish minimum national requirements which reflect good engineering practice.

It is also clear that many differences exist between States, including geological conditions, use and availability of ground water, and intensity of underground injection operations. For this reason the regulations are designed to allow a State to exercise maximum flexibility in order to prevent underground injection practices from contaminating drinking water sources.

Legal Framework of the Regulations

Section 1421 of the Act defines the basic requirements of EPA's regulations for State underground injection control programs. The Administrator must promulgate regulations which contain minimum requirements for effective programs to prevent underground injection practices which endanger potential or present drinking water sources. In accordance with this mandate, the principal purpose of the regulations is to prevent endangerment of underground drinking water sources, and the burden is placed on the underground injection operator to demonstrate that his operation will not result in endangerment. Section 146. 2(x) of the proposed regulations seeks to clarify what is meant by "endangerment" by defining that term to include the contamination or potential contamination of an aquifer which may result in the need for additional treatment of water from the aquifer to make it suitable for drinking. Comments on this definition and suggestions for alternative approaches are welcome. EPA believes that the definition of endangerment should be construed liberally so as to effectuate the preventive and public health protective purposes of the Act. Therefore, the proposed regulations seek to prevent the injection of materials which may enter a present or potential drinking water source and pose a threat to human health or otherwise render a present or potential water source unfit for human consumption. Necessarily, the regulations seek to prevent the injection of materials which may force a public water system to expend funds to comply with any national primary drinking water regulation or otherwise to avoid endangerment to the public health.

Section 1421(b)(2) states that regulations for State underground injection programs may not prescribe a requirement which interferes with or impedes underground injection in connection with oil and natural gas production or the secondary or tertiary recovery of oil and natural gas unless such a requirement is essential to assure that underground sources of drinking water will not be endangered by such injection. The House Report accompanying the Act defines the term "interfere with or impede" to mean "stop or substantially delay." (Report 93-1185, at 31)

The Administrator need not demonstrate that a particular requirement is essential unless it can be first shown that the requirement interferes with or impedes oil or gas production. As indicated in the House Report, the Administrator does not have an "impossible" burden in establishing the essentiality of a requirement. (Report 93-1185, at 31) Moreover, as discussed above, the Agency intends to interpret the term "endangerment" broadly so as to effectuate the purposes of the Act. Recognizing the complexity, intensity, age and experience in regulating injection operations as they relate to oil and gas production and the fact that several alternative methods have been demonstrated to be equally effective in protection of underground sources of drinking water proposed Subsection 146. 42(c) provides that a State Director may approve an alternative method of protection to specific minimum requirements contained in Section 146. 42(a), if the operator clearly demonstrates that (i) the requirement would stop or substantially delay oil or natural gas production at his site; and (ii) the requirement is not necessary to assure the protection of an existing or potential source of underground drinking water. Section 146. 42(c) applies only to specific wells or injections. Section 146. 42(b) provides that the Director may designate specific geographical areas where an alternative method to the requirements in Section 146. 42(a)(1) or (a)(2) may be employed.

Section 1422(a) of the Act requires the Administrator to list in the FEDERAL REGISTER those States for which a State underground injection control program may be necessary to assure that underground injection will not endanger drinking water sources. Such a determination will not be based on the adequacy of an existing State program but will be initially based on the dependency of a State on ground water as a source of drinking water and the magnitude of underground injection operations in a State. All States will eventually be listed. Under Section 1422(b) of the Act, a State so listed must submit a State program to the Administrator within 270 days after being named. If the State program does not fully meet the requirements of the Act and applicable regulations, or if no State program is submitted, the Administrator must prescribe a program for the State within 90 days. The States will be listed within 90 days of the publication of this notice (40 F. Reg. 31034, July 24, 1975).

If a portion of a State's program meets the requirements of the Act and these regulations, that fact will be taken into account in the Administrator's prescription and administration of a program for the State. EPA will administer only that portion of an underground injection control program for the State for which the State's program is not adequate. However, Section 1421 of the Act makes clear that the State cannot assume overall "primary enforcement authority" unless all of its program is approved by the Administrator. If a State does not assume primary enforcement responsibility, it cannot be awarded program grant funds related to an underground injection control program after an initial two-year period, and the Administrator will have direct enforcement authority in the State pursuant to Section 1423 of the Act.

State underground injection control programs under Section 1421 of the Act are considered separately from State public water system supervision programs under Section 1413. A State does not have to qualify for primary enforcement responsibility for public water systems to qualify for primary enforcement responsibility for underground injection.

Section 1421 of the Act requires the Administrator to promulgate regulations establishing minimum requirements for the State underground injection control programs. Sections 1421 also specifies some of those requirements. The regulations must require that a State program, to be approved under Section 1422--

> (A) shall prohibit, effective three years after the date of the enactment of this title, any underground injection in such State which is not authorized by a permit issued by the State (except that the regulations may permit a State to authorize underground injection by rule);
>
> (B) shall require (i) in the case of a program which provides for authorization of underground injection by permit, that the applicant for the permit to inject satisfy the State that the underground injection will not endanger drinking water sources, and (ii) in the case of a program which provides for such an authorization by rule, that no rule may be promulgated which authorizes any underground injection which endangers drinking water sources;
>
> (C) shall include inspection, monitoring, recordkeeping, and reporting requirements; and

(D) shall apply (i) as prescribed by Section 1447(b), to underground injections by Federal agencies, and (ii) to underground injections by any other persons whether or not occurring on property owned or leased by the United States.

Within the framework of Section 1421(b), the Agency has based the proposed regulation on its review of thirty-one existing State programs and on technical and policy input from a diverse work group including four State officials (Texas, Kansas, Florida and Michigan), the U. S. Geological Survey, five regional EPA representatives (Regions VI, IX and X), three representatives from USEPA laboratories, and seven representatives from USEPA headquarters. Comments were also solicited from State program officials, industry representatives, and environmental groups.

Scope of the Regulations

The Act defines "underground injection" as the "subsurface emplacement of fluids by well injection" (Section 1421(d)(1)).

The scope of the coverage of these regulations is determined by the definition of "well injection." The term is not explicitly defined in the Act of the legislative history. Upon examination of the purpose and legislative history of the Act, EPA is including the following definition in proposed Section 146. 2(r):

> Well injection means subsurface emplacement through a bored, drilled, or driven well, or through a dug well where the depth is greater than the largest surface dimension, whenever a principal function of the well is the subsurface emplacement of fluids.

The term "well injection" is defined in terms of the function of a well. As well as including what is normally referred to as the "deep well" injection of industrial or municipal wastes, the proposed definition of "well injection" also includes a number of well injection practices other than "deep well" waste disposal, including the subsurface emplacement of fluids generally, not just waste disposal. This definition is supported by the House Report, which states:

> The definition of underground injection is intended to be broad enough to cover any contaminant which may be put below ground level and which flows or moves, whether the contaminant is semi-solid, liquid, sludge or any other form or state.
>
> This definition is not limited to the injection of wastes or to injection for disposal purposes; it is intended also to cover, among other contaminants, the injection of brines and the injection of contaminants for extraction or other purposes. (Report 93-1185, at 31)

The proposed definition includes drilled wells, since these are the type of wells used in the practices most often mentioned in the legislative history as requiring regulation. It also covers bored and driven wells, which are similar in concept and are used for the same purposes in appropriate situations.

The proposed definition includes dug wells in the definition of well injection practices only when the depth of the well is at least greater than the largest surface dimension of the well. Imposing this depth-width limitation is an effort to adhere to a common view of a well, that it is substantially deeper than it is wide.

Several factors were considered and rejected in the development of the definition of "well injection." For example, as noted in the legislative history above, the nature of the fluid emplaced is not a controlling factor. Also, the legislative history does not suggest that subsurface emplacement of fluids becomes "underground injection" at some predetermined depth below the surface.

A simple way to define "injection" in the context in which it is used in the statute would be to relate it to mechanically induced pressure. However, the clear purpose of the Act is to prevent the endangerment of underground drinking water sources through the injection of fluids, and there is no reason to distinguish between mechanical pressure and gravity flow injection.

The proposed definition does not cover practices which in many cases endnager underground drinking water because they cannot be deemed to be "underground injection" within the meaning of Section 1421(d)(1) of the Act. For example, leakage from sewer mains, septic systems, highway salting and leaching from landfills appear to be very serious sources of contamination of underground drinking water, but they are not underground injection practices and therefore are not regulated by Part C of the Act. It also does not cover a situation such as the construction of an oil or gas production well or those surface impoundments where incidental subsurface emplacement of fluids occurs but is not a principal function of the operation.

In Section 146.2(r), the term "dug well" applies only to impoundments where the depth is greater than the largest surface dimension. However, the term "dug well" also can be applied technically to surface impoundments, such as pits, ponds and lagoons, where the depth is less than the largest surface dimension. (See Meinzer, Outline of Ground-Water Hydrology with Definitions). What is unclear is whether these dug wells which also have as a principal function the subsurface emplacement of fluids are also covered by the Act.

What is clear is that there are tens of thousands of dug wells -- including industrial and municipal pits, ponds and lagoons used for waste treatment, storage or disposal--which pose a very serious potential hazard to underground drinking water. EPA proposes to attack the problem of these dug wells, including pits, ponds and lagoons, in the following manner:

1. Proposed Section 146.16(b) requires States to undertake a survey of dug wells to determine the extent to which they function to emplace fluids underground and the hazards they pose to underground drinking water sources.
2. EPA will seek to obtain needed additional data on these dug wells through the study of pits, ponds and lagoons authorized by Section 1442 of the Act.

3. When enough data is available to determine which dug wells should be regulated and how they should be regulated, EPA will endeavor to amend the defintion of "well injection" to the extent possible to cover additional dug wells or will seek such additional legislation as may be necessary. It is EPA's intention that any broadening of the regulation of dug wells would not take effect for at least two years after the effective date of the initial underground injection control regulations, in the interest of orderly administration of the State programs.

However, it should be noted that EPA could act to prevent such endangerment under Section 1431, the emergency powers provision of the Act. EPA is studying the effects of these and other sources of ground-water contamination. In the meantime, the States are encouraged to continue their efforts to regulate a broad range of sources of contamination which do not fall within the meaning of "underground injection" as that term is used in the Act.

Comments are encouraged on ways in which those dug wells which have as a principal function the underground emplacement fluids can be defined and included in an underground injection control program.

Framework of the Regulations

These regulations are established to provide the minimum requirements for regulating the underground injection of fluids by the practice of well injection. The practices which are covered by the proposed regulations include injection through any bored, drilled or driven well, or any dug well, where the depth is greater than the largest surface dimension, whenever a principal function of the well is the subsurface emplacement of fluids.

This covers several hundred industrial and municipal waste disposal wells, wells used to inject materials into underground strata for storage, recharge wells, barrier wells, subsidence control wells, mining wells, geothermal wells, brine disposal wells, injection wells used in connection with oil and gas recovery, and drainage wells used for the purpose of disposal of storm water runoff and irrigation return flow.

The proposed regulations include three categories for different types of underground injection practices. Subpart C includes waste disposal wells, wells used to inject materials into underground strata for storage, recharge wells, barrier wells, subsidence control wells, geothermal wells and mining wells. Permits would be required for all such wells, although wells in existence on the effective date of the State program could be regulated by general rule for a period of up to five years pending review of the well by the State. Subpart D includes underground injection wells associated with oil and gas production. Owing to the unique nature and diversity of these wells, Subpart D allows greater flexibility to the States in regulating these wells. As in the case of Subpart C, a permit would be required for these wells also. Subpart D wells in existence on the effective date of the State program could also be regulated by general rule for a period of up to five years pending review of the wells by the State. Review of existing wells could be conducted on a field-by-field or similar approach by the State to simplify the permitting of existing wells and to avoid duplicative data requirements. Subpart E governs drainage wells. These wells can be regulated by permit or by rule, at the option of the State. Maximum flexibility is given to the States for regulation of these types of underground injection wells.

Comments are invited on the categorization of well injection practices used in the regulations and the adequacy of coverage of the regulations.

Approval of State Programs

Subpart B of the proposed regulations sets forth the procedures for the approval of State programs. Proposed Section 146. 10 lists the basic requirements for approval. One of those requirements is that a State program must follow the pattern of regulations by rule or permit established in Subparts C, D, and E. In other words, a State program must follow the requirements of Subpart C in its regulation of waste disposal wells and engineering wells. The State program regulating injection wells related to oil and gas production must follow the requirements of Subpart D. With respect to other types of injection wells, the State program may regulate by a permit system or by rules of general applicability or by a combination of the two, so long as it meets the minimum requirements of Subpart E.

Proposed Section 146. 12 sets out the requirements for an application for a State program. It is not intended that a State include all possible information about its program, but a State must submit the relevant State statutes and regulations and a description of the State's enforcement procedures. This includes designation of geographical areas under Sections 146. 11 and 146. 42(b).

Under proposed Section 146. 13, the Administrator will give public notice of a request for approval of a State program, and will invite comment. Action must be taken on the State application within 90 days after its receipt. Opportunity for public hearing is required by Section 1422(b)(4) of the Act.

Once a State program is approved by the Administrator, it will remain in effect until such time as the Administrator determines that the program no longer meets applicable requirements. To facilitate the Administrator's consideration of the continued compliance of a State program with applicable requirements, proposed Section 146. 15 requires that the State retain pertinent records on outstanding State-issued permits and on violations of State requirements. In addition, under proposed Section 146. 16 a State would be required to submit to the Administrator, for approval, information on any proposed material changes in the State program. This includes designation of geographical areas under Sections 146. 11 and 146. 42(b). The State also would be required to submit on April 1 of each year a brief annual report updating the State's inventory of underground injections (a summary, not a facility-by-facility description) and summarizing violations of State statutes and regulations and of enforcement actions taken by the State.

Key Provisions of the Proposed Regulations

A. Endangerment of Drinking Water Sources

The goal of any requirement for the protection of underground water sources is set by the statute as preventing the endangerment of drinking water sources. As provided by Section 1421(d)(2): of the Act:

> Underground injection endangers drinking water sources if such injection may result in the presence in underground water which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons.

The House Report accompanying the Act provides some guidance as to which underground water sources can reasonably be expected to supply any public water system. The Report indicates that any underground source with a level of total dissolved solids of 10,000 mg/l or less should be protected. (Report 93-1185, at 32) Proposed Section 146.2(g) defines underground drinking water sources accordingly. However, EPA believes that there should be some means of excluding individual aquifers or parts of aquifers which are not in fact potential sources of drinking water even though they have total dissolved solids levels of less than 10,000 mg/l. For example, an aquifer may be oil-producing even with a TDS level of less than 10,000 mg/l, and in such a case it may be wise to give the oil-producing qualities of the aquifer precedence over its ability to provide drinking water. Also, some aquifers below the 10,000 mg/l level are so contaminated that as a practical matter they are not potential drinking water sources.

Because it would be a misallocation of resources to seek to protect as potential drinking water sources aquifers which in fact will not be used by public water systems, proposed Section 146. 11(a) provides that a State program may designate one or more aquifers or portions thereof in the State which have a TDS level below 10, 000 mg/l but which will not be protected because they are oil-producing, are severely contaminated or located in such a way that use as drinking water is impracticable. The State must demonstrate by compelling evidence that an aquifer is and will continue to be unsuitable as a source of drinking water. As part of the State program, the designation would be subject to public notice and public hearing prior to submission to EPA. The regulations also provide, in Section 146. 11(b), that a State may designate geographical areas where no underground drinking water sources exist. In such geographical areas, the requirements of Subparts C, D, and E would not apply. Comment is requested on this approach to selecting aquifers which do not require protection as potential drinking water sources.

Once the aquifers to be protected are identified, the question remains as to the degree of protection to be given. The Act defines "endangerment of drinking water sources" to mean the presence of a contaminant which "may result in [a public water] system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons." Where an existing system using an underground water source, the logical meaning of this provision is that contamination endangers drinking water if it requires the use of new or additional treatment by the system to meet a national primary drinking water regulation or otherwise to prevent a health risk. In many instances there would be a time lag between the time of contamination and the initiation of the new treatment. Diversion of water system resources to deal with such preventable contamination is an inefficient approach to the problem of providing safe drinking water to all persons.

The question of endangerment of underground drinking water sources is more difficult with respect to potential sources not currently used by public water systems. It could be argued that potential sources of underground water are endangered whenever they are degraded. Where a potential source of underground water which would meet primary drinking water regulations without treatment, degradation of that water may make treatment necessary. In the case of a potential source of underground water which will require treatment if it is used in the future, degradation may make further treatment necessary or may make the water unsuitable for use as drinking water.

The problem of what constitutes "endangerment" is further complicated by the fact that it is expected that several contaminants not covered by the national interim primary drinking water regulations will be covered within a few years by the revised regulations. It can also be anticipated that new contaminants will be added to the revised regulations from time to time thereafter. How can underground injection control programs protect underground water sources from "endangerment" by contamination with materials which are not now prohibited in any concentration in drinking water but which may be limited by future maximum contaminant levels?

Finally, there is the statutory mandate to protect underground water sources from any contamination which "may otherwise adversely affect the health of persons." The legislative history of the SDWA suggests that this language means, at the least, that contamination by underground injection which causes ground water to be unpalatable is prohibited. (Report 93-1185, at 32) The justification for such a prohibition is that it makes little difference that water can meet applicable primary regulations if for aesthetic or other reasons it is undrinkable. Clearly there can be other types of contamination which "may otherwise adversely affect the health of persons." For example, water with offensive taste, odor, or color may force the use of alternative water sources of poorer quality. Also, even if a specific dangerous pesticide or other toxic chemical is not covered by the primary regulations because it is not usually found in drinking water supplies, the contamination of an underground drinking water source by that chemical could adversely affect the health of persons who obtain the drinking water from that source.

Despite the difficulty of defining endangerment of drinking water as that term is used in the statute, the task must be undertaken in these regulations. For although every effort will be made to permit consideration of local geological conditions, local laws and local procedures, the basic health standards to be applied in underground injection control programs should be uniform across the country. It was the intent of Congress to accommodate local differences within the framework of a national policy for the protection of the health of the Nation's citizens.

Endangerment of drinking water sources is defined in proposed Section 146. 2(x) as follows:

> Underground injection "endangers underground drinking water sources" if (1) such injection may make it necessary for a public water system using an underground drinking water source to increase treatment of the water, or (2) if such injection might make it necessary for a public water system which uses the source in the future to use more extensive treatment of the water than would otherwise have been necessary, or (3) if such injection may otherwise adversely affect the health of persons such as by adding a substance that would make water from the source unfit for human consumption.

It is expected that the application of the definition of endangerment will be different in the case of existing underground injection than in the case of new underground injection. An applicant for a permit for underground injection will be expected to demonstrate to the satisfaction of the State that the injection will not endanger underground drinking water sources. However, in the case of an existing injection, the applicant normally will be able to show, based on the history of the operation, that continued operation will not require additional treatment of ground water for drinking water use and will not otherwise adversely affect the health of persons such as by making the water unfit for use as drinking water. New underground injections, or a substantial change in an existing underground injection, will be expected to bear a heavier burden of proof.

Comments on the definition of the endangerment of drinking water sources and how that definition might be applied in the regulations are welcomed.

B. Comparison of Subparts C and D

1. Standards for Existing and New Injection Wells

Existing wells under both subparts C (waste disposal wells and engineering wells) and D (oil or natural gas production) could be regulated by rule for a period of up to five years after approval of the State program so long as such wells do not endanger underground drinking water sources. Proposed Section 146.10(a) would prohibit new underground injection under both subparts without a permit. Section 1421(b)(1)(A) of the Act authorizes EPA to permit a State to regulate underground injection by rule or permit, and the legislative history of this provision states:

> In order to implement these controls to protect drinking sources with minimum administrative redtape, the Committee decided to allow EPA discretion to utilize a permit system, rulemaking, or a combination of the two to control underground injection. (Report 93-1185, at 30)

Accordingly, EPA believes that it is prudent to allow States to phase-in permit procedures for existing wells under Subparts C and D so long as underground sources of drinking water are protected by appropriate rules. Consistent with this effort to minimize redtape, proposed Section 146.41(a)(1) provides that a State Director has discretion to require appropriate information in permit applications for existing underground injections under Subpart D. By comparison, the information set out in proposed Section 146.47 is required in all permit applications for new injection sites under Subpart D. Similarly, the information set out in proposed Section 146.24 under Subpart C is required in permit application for both new and existing operations. The reason behind this distinction is the large number of existing injection wells related to oil or gas production and the vast amount of data already on file in the States. By granting the Director discretion with respect to information requirements for these wells, EPA anticipates that a State will be able to focus its resources on critical existing injection sites without becoming enveloped in an unduly burdensome permit program for existing wells.

2. Permit System for Subparts C and D

As noted above, permits would be required for all underground injections which commence operation in a State after approval of the State program ("New underground injections"). Permits would be required for all underground injection operations in operation prior to approval of the State program within five years of approval. Section 1421(b) of the Act does not specify any type of hearing as a prerequisite to the issuance of a permit, but the regulations provide for an opportunity for informal public hearing prior to the issuance of permits under Subparts C (Section 146. 28) and D (Section 146. 45). Proposed Section 146. 4 provides the Director with discretion in determining necessary requirements for the renewal of permits after five years. Public notice of the renewal of a permit would be required by proposed Section 146. 5. It is anticipated that State administrative procedures will provide for judicial review of permit proceedings.

3. Temporary Permits

Section 1421(c)(1) of the Act allows the Administrator to authorize a State to issue temporary permits for existing underground injection operations, effective until December of 1978, when the State is unable to process all permits within the time available. The authority can be given to a State only under the conditions spelled out in Section 1421(c)(1), and only under an application for the authority from the Governor of the State. Under the proposed regulations, Section 1421(c)(1) authority would not be necessary because the States would be allowed to regulate wells covered by Subparts C and D by rule rather than by permit for up to five years and to regulate drainage wells by rule indefinitely.

Section 1421(c)(2) of the Act permits the Administrator to authorize a State, again only under an application from the Governor of the State, to issue temporary permits amounting to variances from the prohibition of endangerment of underground drinking water sources. As in the case of the Section 1421(c) (1) temporary permits, these permits cannot be effective later than December of 1978. Furthermore, a temporary permit under Section 1421(c)(2) cannot be issued by a State until the State can find, based on the record of a hearing, that each of the following requirements are met:

(A) that technology (or other means) to permit safe injection of the fluid in accordance with the applicable underground injection control program is not generally available (taking costs into consideration);

(B) that injection of the fluid would be less harmful to health than the use of other available means of disposing of waste or producing the desired product; and

(C) that available technology or other means have been employed (and will be employed) to reduce the volume and toxicity of the fluid and to minimize the potential adverse effect of the injection on the public health.

C. Subpart E

Proposed Subpart E allows a State program to exercise great flexibility in designing a program for the control of drainage wells. A State may regulate these wells by either rule or permit, or a combination thereof. While seeking to prevent drainage wells from endangering underground water sources, EPA recognizes that the number and diverse characteristics of drainage wells make it extremely difficult to establish specific requirements under Subpart E. Accordingly, EPA has allowed State programs maximum flexibility to deal with drainage wells on a case by case basis, if necessary. As such, EPA intends to monitor State programs under Subpart E and carefully analyze the efficacy of this approach.

D. Remedial Action Under Subparts C, D and E

Underground injection operations regulated under Subpart C, D, or E that are found to endanger underground drinking water sources are required to discontinue operations until remedial action is taken unless the Director determines that it is unreasonable and impracticable to discontinue operations while taking remedial action. If the Director permits an endangering operation to continue operation while taking remedial action, the Director must prescribe a compliance schedule which shall require remedial action to be taken as soon as practicable but in no case later than one year following the determination of endangerment. It is expected that State Directors will require cessation of injection in cases where an imminent health problem may result from such an injection.

Specific Provisions of the Regulations

A. Review of Completion and Plugging Reports

Proposed Section 146. 22(f) requires that "all well completion and plugging reports" for wells penetrating the proposed injection zone within a two mile radius of the proposed well injection be reviewed to insure that all wells that, in the judgment of the Director, present a potential threat to underground drinking water sources are properly completed or plugged. In Section 146. 42(a)(6) dealing with oil and gas production this review is also required except that the radius is reduced to one-half mile. These requirements are intended to prevent the contamination of underground drinking water sources by formation fluids or injected fluids migrating up improperly completed or plugged wells into fresh water formations.

EPA feels that the same minimum regulations should apply to both waste disposal wells and engineering wells because they share common construction, engineering, and operational characteristics. Most States have defined policies for waste disposal wells but few policies exist on the engineering wells. Fourteen States entirely ban the use of waste disposal wells. Twelve States have specific regulations applying to waste disposal wells. The requirements relating to radius of review vary, but a two mile or greater radius is most common. Texas, which now regulates over 40% of all such wells, requires a two and one-half mile radius of review. Twenty other States have policies requiring a careful case by case review of waste disposal wells. Therefore, on the basis of the Texas requirement and the fourteen States which ban waste disposal wells, EPA does not feel that a minimum radius of review below two miles would be appropriate. It is important to note that these regulations neither require those States which ban waste disposal wells to permit them in the future nor require a State such as Texas to adopt less stringent requirements. To the contrary, EPA encourages States to adopt more stringent requirements, if necessary, to prevent the endangerment of underground water sources.

State regulations demonstrate flexibility with respect to injection wells related to oil and gas production. Thirty of the thirty-one oil producing States require a plat denoting ownership and location of all wells including oil, gas, drilling and dry holes. Seventeen of the thirty-one States have specified that all wells within a one-half mile radius of the proposed injection wells should be indicated on a map or plot and that the injected fluid will not cause damage to oil, gas, fresh water or other natural resources. Further, it should be noted that the plugging or completion requirement applies only to those wells penetrating the injection zone which pose a potential danger to underground drinking water sources. It is incumbent on the injector to demonstrate that no hazard exists.

B. Surface Casing Requirements

Proposed Sections 146.22(a) and 146.42(a)(1) require that "all underground drinking water sources of 3,000 mg/l total dissolved solids or less (be) protected by surface casing cemented to the surface."

The House Report accompanying the SDWA recommended that all ground water up to 10,000 mg/l TDS be protected as potential drinking water sources. Discussion with major oil producing States indicated that existing practice requires protecting ground water containing up to 3,000 mg/l TDS with surface casing as potential drinking water sources. In light of these existing provisions, the 3,000 mg/l limit has been established as a minimum standard. Of course, where underground injection would endanger a present or potential source of drinking water containing up to 10,000 mg/1 TDS, EPA expects States to protect such a source.

It is recognized, however, that in oil producing States there are specific areas where alternate methods of protection have been utilized effectively in the past to protect ground water and can be used to do so in the future. Therefore, the Director is given discretion under Section 146.42(b) to permit the continued use of this practice within specified areas of the State provided a public hearing is held. Compelling evidence must be adduced at such a hearing to demonstrate that the continued use of the practice will not endanger underground sources of drinking water. The alternative chosen will be applicable to all wells within the specific area.

C. Tubing and Packer

Proposed Sections 146.22(c) and 146.42(a)(2) require that "injection is maintained through tubing with a suitable packer set immediately above the injection zone." Most State regulations and those knowledgeable in the field of underground injection recommend that tubing and packer or fluid seal be used to isolate the injection zone from potential drinking water sources which may be endangered as a result of the injection of fluids.

It is recognized, however, that there are some areas where alternative methods of protection have been used and can continue to be used effectively to protect ground water. For this reason, the Director is given the discretion to permit the continued use of this practice under Section 146. 42(b) provided a public hearing is held. Compelling evidence must be adduced at such a hearing to demonstrate that the continued use of the practice will not endanger underground sources of drinking water. The alternative chosen will be applicable to all wells within the specific area. The Director may also approve alternative methods under Section 146. 22(c) where they are demonstrated to be equally effective.

D. Annular Injection

Section 146. 2(z) defines "annular injection" as any injection between strings of casing, between tubing and casing, between strings of tubing and between casing and hole. The following sections deal with the differing types of protection necessary to protect drinking water sources from the three common types of annular injection.

Section 146.42(a)(7) prohibits annular injection between the casing and the hole. With this type of annular injection, there is no protection for underground sources of drinking water.

Section 146.42(a)(8) prohibits annular injection between strings of casing and between tubing and casing, except that the Director may approve such injection provided: (1) there is an annulus between the outer string of casing receiving the injection, and the surface casing which can and will be monitored for leaks; (2) that the surface casing is protected by cement to the surface; and (3) that the injector demonstrates to the satisfaction of the Director that the injection will not endanger underground sources of drinking water.

Section 146.42(a)(9) prohibits annular injection between the surface casing and the next innermost casing or between the surface casing and the tubing, or injection through the surface casing only; except that the Director may approve such injection where: (1) the injection was in operation prior to approval of the proposed State program, and; (2) the injector demonstrates to the satisfaction of the Director that, based on previous history and presentation of compelling evidence collected through fluid injection profile surveys or monitoring wells that the injection has not endangered underground sources of drinking water, nor will its continued use endanger underground sources of drinking water. Comments are solicited on the adequacy of these requirements in protecting underground sources of drinking water and on the impact of these requirements on existing wells.

E. Monitoring Well

Section 146.42(a)(9) permits presentation of evidence gathered from monitoring wells in support of a demonstration of non-endangerment from an annular injection. These monitoring wells may be drilled specifically for this purpose or they may be producing water wells currently in place providing they draw water from the base of fresh water within the calculated zone of influence of the injection well.

F. Supplemental Data Acquisition

Section 146.47(b) contains a list of additional data which is desirable to have in evaluating an application for well injection. It should be noted, however, that it is not necessary to collect this data in every case. This data should be collected only where necessary to make the necessary determinations.

G. Presentation of Compelling Evidence

Sections 146.22(c), 146.42(a)(9), 146.42(c)(1) and 146.42(c)(2) require the presentation of "compelling evidence." "Compelling evidence" means the types and quantity of data necessary to provide a base such that reasonably qualified people would draw the same conclusion. In sections 146.42(c)(1) and (c)(2) "written" compelling evidence is required. This may take the form necessary to satisfy the Director. However, in States where a formal public hearing, including the use of court stenographers and cross examination is required, this procedure may be utilized alone or in support of other requirements by the Director.

H. Categorization Anomalies

There are several special types of wells such as certain recharge wells, mining wells, where current technology mandates utilization of annular injection, and multiple use wells such as those used for water flood and subsidence control which may not readily fit into the current categorization scheme. Comment is solicited on the extent and nature of these wells and on the necessity of developing different minimum requirements than those currently contained in the regulations.

I. Summary of Solicited Comments

Comments are solicited on specific parts of the regulations. These are summarized below:

1. Definition of "underground drinking water source";
2. Definition of "well injection";
3. Definition of "endangers underground drinking water sources";
4. Requiring data to be kept by States in a form admissible as evidence in enforcement proceeding;

5. Adequacy of time for conducting inventory and analyses of surface impoundments;
6. Combination Rule-Permit programmatic staging system for existing injection wells;
7. Handling of confidential information;
8. Adequacy of requirements in preventing endangerment and impact of these requirements on existing annular injection wells; and
9. Alternative methods of determining non-endangerment from wells penetrating injection horizon.

COMMENTS

Interested persons may participate in this rulemaking process by submitting written comments in triplicate to the Office of Water Supply (WH-550), Environmental Protection Agency, Washington, D.C. 20460, Attention: Comment Clerk, State Underground Injection Control Program Regulations.

Comments on all aspects of the proposed regulations are solicited. In addition to considering public comments, the Agency will hold public hearings to receive comments and statements on the proposed regulations. The hearing room locations, dates and times should be confirmed by interested parties in advance by telephone.

October 6, 1976
EPA, Region VIII
900 Lincoln Tower Building
1860 Lincoln Street
Denver, Colorado 80202
Telephone: (303) 837-2731

October 13, 1976
EPA, Region VI
First International Building
1201 Elm Street
Dallas, Texas 75270
Telephone: (214) 749-1962

September 29, 1976
EPA, headquarters
Waterside Mall
401 M Street S.W.
Washington, D.C. 20460
Telephone: (202) 426-3934

All comments received on or before (November 15, 1976) will be considered. A copy of all public comments will be available for inspection and copying from the EPA Freedom of Information Center. As provided in 40 CFR Part 2, a reasonable fee may be charged for copying services.

It is our judgment that these proposed regulations will not have a significant impact on inflation as specified in the Agency's Guidelines on Inflation Impact Statements. Hence, these regulations are not considered major regulatory actions so that they do not require preparation of an Inflation Impact Statement as set forth in Executive Order 11821. However, an economic evaluation has been prepared and is included as Appendix A.

It is hereby announced that a draft Environmental Impact Statement has been prepared on these proposed regulations. Copies of the statement may be obtained from the Office of Water Supply (WH-550), Environmental Protection Agency, Washington, D.C. 20460, Attention: UIC-EIS.

The Council of Environmental Quality will publish in the FEDERAL REGISTER on the second Friday following proposal of these regulations the duration of the comment period. All comments received on or before the date specified by CEQ will be considered.

Comments should be submitted in triplicate to the Office of Water these regulations the duration of the comment period. All comments received on or before the date specified by CEQ will be considered. Comments should be submitted in triplicate to the Office of Water Supply (WH-550), Environmental Protection Agency, Washington, D.C. 20460, Attention: Comment Clerk, Environmental Impact Statement-UIC.

Date: AUG 10 1976

Administrator

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REGULATIONS FOR STATE UNDERGROUND INJECTION CONTROL PROGRAMS

SUBPART A - GENERAL

§ 146.1 Scope and Purpose.

(a) Part C of the Safe Drinking Water Act, Pub. L. 93-523, added to the Public Health Service Act ("the Act") provisions for the protection of present and potential underground drinking water sources from contamination by underground injection of contaminants. Public Health Service Act §§1421-1424, 42 U.S.C. 300-h through 300-h-3.

(b) Section 1422 of the Act provides that the Administrator shall list in the FEDERAL REGISTER each State for which in his judgment a State underground injection control program may be necessary to assure that underground injection will not endanger drinking water sources. Within 270 days after a State is listed, it must submit to the Administrator a State program adequate to protect underground sources of drinking water. If the State program is not submitted or is not approved by the Administrator, an underground injection control program for the State must be prescribed by the Administrator.

(c) Under to Sections 1421, 1422 and 1450 of the Act, this part sets forth procedural and substantive requirements which must be met by State programs to obtain the Administrator's approval. Any State program approved by the Administrator will be subject to the requirements of this part. A State with an approved program in effect shall have primary enforcement responsibility for all underground injection activities in the State, except as noted in paragraph (d).

(d) To qualify for primary enforcement responsibility, a State's program for enforcement of underground injection control regulations must apply to all underground injection practices in the State required to be regulated by this Part, except for:

   (1) underground injection practices on Indian land where the State does not have the necessary jurisdiction or its jurisdiction is in question; or

   (2) an underground injection practice operated by or for a Federal agency where the Administrator has waived compliance with all or part of an applicable underground injection control program under Section 1447(b) of the Act.

(e) Underground injection to be regulated includes underground injection by municipal and industrial waste disposal wells, storage wells, subsidence control wells, mining wells, geothermal wells, barrier wells, recharge wells; underground injection of brine or other fluids which are brought to the surface in connection with oil or natural gas production and underground injection for the secondary or tertiary recovery of oil or natural gas; and underground injection by drainage wells.

§146.2 Definitions.

As used in this part, and except as otherwise specifically provided:

(a) "Act" means the Public Health Service Act.

(b) "Agency" means the United States Environmental Protection Agency.

(c) "Administrator" means the Administrator of the Agency or his authorized representative.

(d) "Regional Administrator" means a Regional Administrator of the Agency.

(e) "Director" means the chief administrative officer of a State ground-water pollution control agency. In the event responsibility for ground-water pollution control and enforcement is divided among two or more State agencies, the term "Director" means the State administrative officer authorized to take the action to which reference is made.

(f) "FWPCA" means the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1314, et seq.

(g) Except as provided in §146.11, "Underground drinking water source" means (1) an aquifer which currently supplies a public water system, or (2) an aquifer which contains water having less than 10,000 mg/l total dissolved solids.

(Note: Comment is solicited on the adequacy of this definition)

(h) "Contaminant" means any physical, chemical, biological, or radiological substance or matter in water.

(i) "Public water system" means a system for the provision to the public of piped water for human consumption, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals daily at least 60 days out of the year. Such term includes (1) any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system, and

(2) any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system.

(j) "State Underground Injection Control Program" (State UIC Program) means a State program for the regulation of the practice of underground injection to protect underground drinking water sources and meeting the requirements of Sections 1421 and 1422 (b)(1)(A)(ii) of the Act and regulations promulgated under those provisions of the Act.

(k) "Underground Injection Control permit application" (UIC permit application) means the State application form including subsequent additions, revisions, or modifications duly promulgated by the Director for application for a UIC permit.

(l) "Underground Injection Control reporting forms" (UIC reporting forms) means any State reporting forms, including subsequent additions, revisions, or modifications duly promulgated by the Director for reporting data and information pursuant to monitoring and other conditions of UIC permits.

(m) "Underground Injection Control permit" (UIC permit) means any permit or equivalent document issued by the

Director, setting forth the terms under which the applicant may inject fluids.

(n) "Aquifer" means a formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield or be capable of yielding significant quantities of water to wells or springs.

(o) "Total dissolved solids" means the entire quantity of inorganic and organic materials dissolved in water.

(p) "Underground injection" means subsurface emplacement of a fluid, or fluids by well injection.

(q) "Fluid" means material which flows or moves, whether semi-solid, liquid, sludge, or any other form or state.

(r) "Well injection" means subsurface emplacement through a bored, drilled, or driven well, or through a dug well where the depth is greater than the largest surface dimension, whenever a principal function of the well is the subsurface emplacement of fluids.

(Note: Comment is solicited on the adequacy of this definition.)

(s) "Surface Impoundment" means any dug well which has a depth less than the greatest surface dimension and is used for collection, storage, treatment, or disposal of fluids.

(t) "Existing underground injection" means underground injection in operation in a State before the approval of the proposed State program pursuant to Section 1422(b) of the Act.

(u) "New underground injection" means underground injection which starts operation in a State after approval of the proposed State program under Section 1422(b) of the Act.

(v) "Person" means an individual, corporation, partnership, association, State, municipality, or Federal agency other than the Agency.

(w) "Municipality" means a city, town, or other public body created by or under State law, or an Indian tribal organization authorized by law.

(x) Underground injection "endangers underground drinking water sources" if (1) such injection may make it necessary for a public water system using an underground drinking water source to increase treatment of the water, or (2) if such injection might make it necessary for a public water system which uses the source in the future to use more extensive treatment of the water than would otherwise have been necessary, or (3) if such injection may otherwise adversely affect the health of persons such as by adding a substance that would make water from the source unfit for human consumption.

(Note: Comment is solicited on the adequacy of this definition.)

(y) "Federal agency" means any department, agency, or instrumentality of the United States.

(z) "Annular injection" means any injection between strings of casing, between tubing and casing, between strings of tubing and between casing and hole.

§146.3 Duration of Permits

No UIC permit may be issued for a term greater than five years.

§146.4 Renewal of UIC Permits

Upon a request by the permittee, the Director may renew a permit, without requiring a formal reapplication by the permittee, after a determination by the Director that the continued operation of the underground injection will not endanger underground sources of drinking water. If the Director determines that the continued operation of the facility may endanger underground sources of drinking water the Director may require the permittee to submit information to demonstrate that the continued operation of the facility will not endanger underground sources of drinking water. If the Director finds that the permittee has failed to demonstrate the continued operation will not endanger underground sources of drinking water, the Director shall refuse to reissue the permit. The Director's decision shall be set forth in writing, and a copy furnished to the applicant.

§146.5 Public Notice of Renewal of UIC Permits

The Director shall give Public Notice of the intent to renew a UIC Permit or group of permits under either Section 146.26(a), 146.43(a) and 146.72(b).

SUBPART B - STATE UNDERGROUND INJECTION CONTROL PROGRAMS

§146.10 Requirements for Approval of a State Underground Injection Control Program.

The Administrator will approve a proposed State underground injection control program under Section 1422 of the Act if the State program:

(a) Prohibits, effective December 16, 1977, or as of the time of the Administrator's approval, any underground injection covered by Subparts C or D which is not authorized by a permit issued by the State; except that if underground injection in operation prior to the approval of the State Program under Section 1422(b) of the Act, the State program may authorize continued operation by rule for a period of up to five years from the date of designation;

(b) Prohibits, effective December 16, 1977, or as of the time of the Administrator's approval, any underground injection covered by Subpart E which is not authorized by a rule or permit issued by the State;

(c) Complies with Subparts C, D and E, which set forth requirements for the various categories of underground injection;

(d) Applies to underground injection by any person within the boundaries of the State, including any Federal agency, except for:

(1) underground injection practices on Indian land which the State does not have the necessary jurisdiction or its jurisdiction is in question; or

(2) an underground injection practice operated by or for a Federal agency where the Administrator has waived compliance with all or part of an applicable underground injection control program under Section 1447(b) of the Act.

(e) Includes statutory or regulatory enforcement authority adequate to compel compliance with State requirements which seek to prevent the endangerment of underground drinking water sources by underground injection, such authority to include:

(1) Authority to sue in courts of competent jurisdiction to enjoin any threatened, or continuing violation of the State underground injection control regulations;

(2) Right of entry and inspection of underground injection facilities, including the right to monitor or take samples, whether or not the

State has evidence that the facility is in violation of an applicable legal requirement;

(3) Authority to require operators of underground injection facilities to keep appropriate records and make appropriate reports to the State; and

(4) Authority to assess civil or criminal penalties for violation of the State's underground injection control regulations including the authority to assess daily penalties or multiple penalties when a violation continues;

(f) Insures that any information on file with the State and pertinent to UIC applications and permits shall be available to the public for inspection and copying subject to appropriate protection of trade secrets;

(g) Includes inspection and surveillance procedures which with reasonable assurance will determine, independent of information supplied by applicants and permittees, compliance or noncompliance with applicable standards and limitations, UIC permit filing requirements, and issued UIC permits or terms or conditions thereof. Such surveillance and inspection support procedures shall include the following:

(1) A supporting survey program with sufficient capability to make systematic surveys of operations subject to the Director's authority in order to identify and locate all operations subject to UIC permit filing requirements;

(2) A supporting inspection program for the periodic inspection of underground injection operations, systems, or facilities. Such inspection shall determine compliance or noncompliance with the terms, conditions, limitations and schedules of compliance in UIC permits; and

(h) Has been adopted after reasonable notice and public hearings.

§146.11 Aquifers Protected by a State Program.

(a) Notwithstanding §146.2(g) -- which defines "underground drinking water sources" to encompass aquifers which do not currently supply a public water system but which contain water having less than 10,000 mg/l total dissolved solids -- a State program which does not undertake to protect one or more such aquifers or portions thereof may meet the requirements for primary enforcement responsibility if the State can demonstrate to EPA that the aquifer or portion thereof is not an underground drinking water source because the aquifer is either oil-producing; is too contaminated for use as an underground drinking water source; or is in a location which makes future use of the aquifer as an underground drinking water source impracticable, and that the injection into such aquifer would not endanger underground drinking water sources in another part of the aquifer or in another aquifer.

(b) The State program may designate specific geographic areas which do not contain underground sources of drinking water as defined in §146.2(g), in which underground injection is not subject to these regulations. The State must clearly demonstrate to EPA that within that specified area no underground drinking water sources exist, and further that underground injection in such a geographic area would not endanger underground drinking water sources outside that area.

(c) A complete record of all evidence as well as all analyses of such evidence related to designations under (a)(b) above shall be submitted to the Administrator upon submission of the State Program under Section 1422(b) of the Act. All injection wells located in the designated area shall be identified as a part of the submission to the Administrator. Such designations are subject to the requirements of Section 146.10(h) and 146.14(a). If an area is to be designated after approval of the State Program the procedure contained in this paragraph must be followed.

§ 146.12 Request for Approval of a State Underground Injection Control Program.

A State may apply to the Administrator for approval of its underground injection control program under Section 146.10. The application shall be as concise as possible, shall describe and document the State's compliance with the requirements set forth in Section 146.10, and shall include the following information:

(a) The text of the State's statutory authority and regulations pertaining to the State underground injection control program; and

(b) A brief description, accompanied by appropriate documentation, of the State's procedures for the enforcement of its underground injection control program, including State inspection, monitoring, recordkeeping and reporting requirements..

§146.13 Action on Request for Approval of a State Program.

(a)(1) Upon receipt of a request for approval of a State program submitted under Section 146.12, the Administrator shall publish notice of the request in the FEDERAL REGISTER and in a newspaper or news papers of general circulation in the State involved, with a brief summary of the State program, and shall invite comments on the request.

(2) Within 90 days after receipt of the State's completed application, the Administrator shall either approve, disapprove, or approve in part and disapprove in part, the State program. The Administrator's action shall take effect in accordance with Section 146.14.

(b) (1) If the Administrator approves the State program, the State shall have primary enforcement responsibility for underground injection control in the State until such time as the approval is terminated under this subsection (b).

(2) The Administrator shall periodically review, with respect to each State determined to have primary enforcement responsibility, the compliance of the State with the requirements set forth in Section 146.10.

(3) When the Administrator's periodic review, or other information available to him, indicates that a State no longer meets the requirements set forth in Section 146.10, he shall notify the State in writing of that fact

and shall summarize in his notice the information available to him which indicates that the State no longer meets such requirements.

(4) The State notified under subparagraph (3) of this paragraph may, within 30 days of receiving the Administrator's notice, submit to the Administrator evidence demonstrating that the State continues to meet the requirements for primary enforcement responsibility.

(5) After reviewing the submission of the State, if any, made under subparagraph (4) the Administrator shall either determine that the State no longer meets the requirements of Section 146.10 or that the State continues to meet those requirements, and shall notify the State of his determination. Any determination that the State no longer meets the requirements of Section 146.10 shall not become effective except as provided in Section 146.14.

§ 146.14 Public Hearing.

(a) Before any determination as to the transfer of authority to a State under Section 146.13(a) becomes effective, or any determination pursuant to Section 146.13(b) that a State program no longer meets the requirements of Section 142.10

becomes effective, the Administrator shall provide an opportunity for public hearing on his determination under Section 1422(b)(3) of the Act.

(b) The Administrator shall publish notice of any determination specified in paragraph (a) in the FEDERAL REGISTER and in a newspaper or newpapers of general circulation in the State involved, within 15 days after making such determination, with a statement of his reasons for the determination. The notice shall inform interested persons that they may request a public hearing on the Administrator's determination. Such notice shall also indicate one or more locations in the State where information submitted by the State under Section 146.11 is available for inspection by the general public. A public hearing may be requested by any interested person other than a Federal agency.

(c) Requests for hearing under paragraph (b) shall be submitted to the Administrator within 30 days after publication of notice of opportunity for hearing in the FEDERAL REGISTER. Such requests shall include the following information:

(1) The name, address and telephone number of the individual, organization or other entity requesting

a hearing;

(2) A brief statement of the requesting person's interest in the Administrator's determination and of information that the person making the request intends to submit at such hearing; and

(3) The signature of the individual making the request; or, if the request is made on behalf of an organization or other entity, the signature of a responsible official of the organization or other entity.

(d) If an appropriate request for hearing is submitted in accordance with paragraph (c), the Administrator shall give notice in the FEDERAL REGISTER and in a newspaper or newspapers of general circulation in the State involved, of any hearing to be held according to a request submitted by an interested person or on his own motion. Notice of the hearing shall also be sent to the person requesting a hearing, if any, and to the State involved. Notice of the hearing shall include a statement of the purpose of the hearing, information regarding the time and location for the hearing and the address and telephone number of an office at which interested persons may obtain further information concerning the hearing. At least one hearing location specified in the public notice shall be within the involved State. Notice of hearing shall be given not less than 30 days prior to the time scheduled for the hearing.

(e) Hearings convened under paragraph (d) shall be conducted before a hearing officer to be designated by the Administrator. The hearing shall be conducted by the hearing officer in an informal, orderly and expeditious manner. The hearing officer shall call witnesses, receive oral and written testimony and take such other action as may be necessary to assure the efficient conduct of the hearing. Following the conclusion of the hearing, the hearing officer shall forward the record of the hearing to the Administrator.

(f) After reviewing the record of the hearing and other relevant information, the Administrator shall issue an order affirming the determination referred to in paragraph (a) or rescinding such determination. If the determination is affirmed, it shall become effective as of the date of the Administrator's order.

(g) If no timely request for hearing is received and the Administrator does not determine to hold a hearing on his own motion, the Administrator's determination shall become effective 45 days after notice is issued under paragraph (b) of this section.

(h) If a determination of the Administrator that a State no longer meets the requirements of Section 146.10 becomes effective, the State may later apply for a determination that it meets such requirements by submitting to the Administrator information demonstrating that it has remedied the deficiencies found by the Administrator without adversely affecting other aspects of its program required by Section 146.10.

(i) Within 270 days after any amendment of a Regulation, under Section 1421, revising or adding any requirement, each State shall submit a notice to the Administrator containing a showing satisfactory to him that the State program meets the revised added requirement.

§ 146.15 Records Kept by States.

(a) Each State which has primary enforcement responsibility under Section 1421(b)(1)(c) of the Act shall maintain the following information with respect to each underground injection for which a permit is in effect or for which the Director has received evidence of a violation of applicable requirements:

(1) Reports of any monitoring required by the permit

or other surveillance conducted by the Director;

(2) Copies of permits in effect and the applications for those permits; and

(3) Records of any enforcement actions or evidence of violation of applicable requirements.

(b) Records required to be kept under paragraph (a) must be in a form admissible as evidence in State enforcement proceedings.

(Note: Comment is solicited on the feasibility of requiring data to be kept in this form.)

(c) Each State which has enforcement authority for the injection regulated under Subpart D of these regulations shall maintain complete records of all approvals granted under Section 146.42 (a)(8) and (9) and Section 146.42(c).

§ 146.16 Reports by States.

Each State which has primary enforcement responsibility shall submit to the Administrator the following information:

(a) A complete inventory of all underground injections subject to regulation under Subpart C, D, and E of this Part within one year after approval of the program; and

(b) An inventory of existing surface impoundments, and an assessment of the extent to which they function to emplace fluids underground and an evaluation of the hazard they pose to underground drinking water supplies, within eighteen months after approval of the program, and

> (Note: Comment is solicited on the adequacy of the time for conducting this inventory and subsequent analysis in defining the problem of underground injection through dug wells including surface impoundments not currently covered by this Regulation)

(c) An annual report to be submitted by April 1 of every year, consisting of:

(1) A summary of the number of violations of State underground injection control statutes and regulations and of enforcement actions taken by the State;

(2) An updated list of new and abandoned underground injection operations in the State;

(3) A listing of specific permits issued for underground injections in areas designated under Sections 146.11 and 146.42(b).

(4) A listing of specific permits containing approvals granted under Sections 146.42(a)(8),

146.42(a)(9) and 146.42(c).

(5) Information on any proposed material change in the State program, before adoption of the change.

SUBPART C - REQUIREMENTS APPLICABLE TO WASTE DISPOSAL WELLS AND ENGINEERING WELLS

§146.20 Underground Injections To Which Subpart Applies.

This subpart sets forth requirements for State programs of underground injection by industrial and municipal waste disposal wells, subsidence control wells, barrier wells, recharge wells, mining wells, storage wells and geothermal wells.

§ 146.21 Review of Existing Underground Injections.

(a) Underground injections which were in operation under approval by the Director under an existing State program before the approval of the proposed State program under Section 1422(b) of the Act may, for a period of up to five years after approval, be regulated by rule provided such underground injections will not endanger underground drinking water sources.

(1) The Director shall require applications to be filed under Section 146.24 for each existing underground injection which is to continue in operation.

(2) The Director shall systematically review such underground injections to determine that they do not endanger underground drinking water sources. The method of review to be used must

be indicated in the program submission to EPA along with a time schedule to assure that all existing underground injections will be reviewed within five years.

(3) Underground injection operations that are found to endanger underground drinking water sources shall discontinue operation pending remedial action unless the Director determines that it is unreasonable or impracticable to discontinue operating pending remedial action. If the Director permits an endangering operation to continue pending remedial action the Director shall prescribe a compliance schedule which shall require remedial action to be taken as soon as practicable but not later than one year following the determination of endangerment.

(b) Pending review by the Director, underground injections must comply at a minimum with State rules in effect on date of proposal of the program by the State.

(Note: Comment is solicited on the practicality and impact of this regulatory approach)

§146.22 Requirements for Existing and New Underground Injections.

The Director shall review data on existing underground injections and on proposed new underground injections to assure that:

(a) All underground drinking water sources of 3,000 mg/l total dissolved solids or less are protected by casing cemented to the surface;

(b) The long string is cemented with sufficient cement to assure no migration of injected fluid above or below the injection zone;

(c) Injection is maintained through tubing with a suitable packer set immediately above the injection zone; except that the Director may approve an alternative method of protection where compelling evidence has been presented demonstrating that the alternative method will prevent endangerment of underground drinking water sources. The Director must also offer the opportunity for informal public hearing.

(d) There are no leaks in the system;

(e) Surface injection pressure is limited to preclude the possibility of fracturing the confining strata;

(f) All well completion and plugging reports for wells of record penetrating the proposed injection zone within a two mile radius of the proposed well injection should be thoroughly reviewed to insure that all wells are properly completed and/or plugged that in the judgment of the Director present a potential threat to underground drinking water sources; and

(g) Annular injection is not practiced.

§146.23 General Permit Procedures.

State procedures for permits subject to this subpart shall insure that every applicant for a permit complies with filing requirements to include the following:

(a) The applicant must submit a complete UIC permit application on forms prescribed by the Director, including data required by Section 146.24 except that if the Director determines that the data required is on file with the regulatory agency regulating the injection under consideration, the Director may consider the application complete without resubmission of that specific data.

(b) In the case of new underground injections, a complete UIC permit application must be filed far enough in advance of the date on which it is desired to start the injection to allow adequate consideration of the application, and in sufficient time before starting the injection to insure compliance with any applicable requirement under Section 208 (b)(2)(K) of the FWPCA, and any other applicable regulations; and

(c) Procedures must be established which (1) enable the Director to require submission of additional information after an application has been filed, and (2) insure that, if any UIC permit application is incomplete or otherwise deficient, processing of the application shall not be completed until such time as the applicant has supplied the missing information or otherwise corrected the deficiency.

§146.24 Application for UIC Permit.

Each application for a UIC permit covered by this subpart shall include the following information:

(a) Ownership and Location Data

The application shall identify the owner and operator of the proposed underground injection facility, and the location of the facility.

(b) An accurate map showing (i) location and surface elevation of the injection well, (ii) location of all facilities, (iii) property boundaries, and (iv) surface mineral ownership.

(c) An accurate map showing the location of: water wells; surface bodies of water; oil, gas, exploratory or test wells (with depths of penetration); other injection wells; mines (surface and subsurface) and quarries; and other pertinent surface features including residences, roads, bedrock outcrops, and faults and fractures within a two mile radius of the injection operation.

(d) A tabulation of all wells requested under (c) penetrating the proposed injection zone, showing operator; lease or owner; well number; surface casing size, weight, depth and cementing data for surface, intermediate and long string casings; and plugging data.

(e) Maps and cross sections indicating the vertical and lateral limits of aquifers containing 3,000 mg/l and 10,000 mg/l TDS water quality levels, above and below the injection zone and direction of movement of the water in every underground drinking water source which may be affected by the proposed injection.

(f) Maps and cross sections detailing geologic structure for the local area and generalized maps and cross sections illustrating the regional geologic setting.

(g) Description of chemical, physical, and biological properties and characteristics of the fluid to be injected. (Note: Comment is solicited on the impact of this requirement. Since some information involves trade secrets, how can confidentiality be protected without unduly restraining public involvement?)

(h) Volume, injection rate and injection pressure of the fluid to be injected.

(i) The following geological and physical characteristics of the injection interval and the overlying and underlying confining beds:

(1) thickness;

(2) areal extent;

(3) lithology;

(4) location, extent and effects of known or suspected faulting, fracturing and natural solution channels;

(5) formation fluid chemistry, including total dissolved solids; and

(6) fracturing gradients.

(j) The following engineering data:

(1) diameter of hole and total depth of the well;

(2) type, size, weight, and strength of all casing strings;

(3) proposed cementing procedures and type of cement;

(4) proposed formation testing program;

(5) proposed stimulation program;

(6) proposed injection procedure;

(7) plans of the surface and subsurface construction

details of the system including engineering drawings;

(8) plans for monitoring both well head and annular fluid pressure, fluids being injected in injection zone and other aquifers;

(9) expected changes in pressure, native fluid displacement and direction of movement of injected fluid; and

(10) contingency plans to cope with all shut-ins or well failures to prevent endangerment of underground drinking water sources.

(k) A written evaluation of alternative disposal practices in terms of maximum environmental protection.

§146.25 Formulation of Preliminary Determination and Draft UIC Permits.

(a) The Director shall prepare a preliminary staff determination with respect to a UIC permit application in advance of public notice of the proposed issuance of a UIC permit. The preliminary determination shall include at least the following:

(1) A proposed determination to issue or deny a UIC permit for the injection described in the UIC permit application;

(2) Name and address of the applicant; name of the facility or operation producing the contaminants

to be injected; site or proposed site of the injection; and a list of the alternatives to underground injection which have been considered;

(3) Proposed injection limitations for each major parameter; and

(4) A brief description of any proposed special conditions which will have significant impact upon the injection described in the application.

(b) The Director shall organize the tentative determination, prepared under (a) of this Section into a draft UIC permit.

§146.26 Public Notice Of Proposed Issuance or Denial of UIC Permits for Existing and New Underground Injections

(a) The Director shall give public notice of any preliminary determination to issue or deny a UIC permit. The public notice shall be circulated in a manner designed to inform interested persons of the proposed injection and of the preliminary determination to issue or deny a UIC permit for the proposed injection. At a minimum:

(1) The public notice shall be published in a local newspaper of general circulation;

(2) Notice shall be mailed to any person or group of persons upon request;

(3) The Director shall provide a period of not less than

30 days following the date of the public notice, during which time interested persons may submit written comments regarding the preliminary determination with respect to the UIC permit application. All written comments submitted during the comment period shall be retained by the Director and considered in the formulation of his final determination with respect to the UIC permit application.

(b) The contents of public notice of proposal issuance or denial of UIC permits shall include at least the following:

(1) Name and address of the applicant and a brief description of the location of the injection;

(2) Nature of the applicant's activities or operations which result in the fluid to be injected (e.g., municipal waste treatment plant, steel manufacturing, drainage from mining activities);

(3) A physical, chemical, and biological description the fluid to be injected and the rate and pressure of injection;

(Note: Comment is solicited on the impact of this requirement since some information involves trade secrets. How can confidentiality be protected without unduly restraining public involvement?)

(4) Depth and geologic name of the injection zone or formation;

(5) A statement of the Director's preliminary determination to issue or deny the permit and a brief description of the procedures for the formulation of final determinations, including the comment period and any other means by which interested persons may influence or comment upon those determinations; and

(6) Name of the State Agency issuing the public notice with address and phone number at which interested persons may obtain further information, and inspect and copy UIC application forms and related documents.

§146.27 Notice to Other Government Agencies.

The Director shall also notify other appropriate government agencies of the proposed issuance of a UIC permit and shall provide such agencies an opportunity to submit their written views and recommendations or request a public hearing. Procedures for such notification shall include the following:

(a) At the time of issuance of public notice under Section 146.25, a copy of the notice will be transmitted to the

Director in any other State whose waters may be affected by the issuance of a UIC permit and, upon request, such State will be provided with a copy of the UIC permit application and a copy of the proposed permit. Each potentially affected State may submit written recommendations to the Director (with copies to the Regional Administrator(s) for the affected Region(s)). The Director shall provide the affected State or States (and the Regional Administrator (s)) a written explanation of his reasons for failing to accept any such written recommendations;

(b) A procedure, similar to paragraph (a) of this section, for notifying any interstate agency or commission having ground-water quality control authority over waters which may be affected by the issuance of a permit; and

(c) A procedure for mailing a copy of the public notice of an application for a UIC permit to any other Federal, State, or local agency, or any foreign country, upon request, and providing an opportunity to respond, comment, or request a public hearing pursuant to §146.29. Such agencies shall include at least the following:

(1) The agency responsible for the preparation of an approved plan under Section 208(b)(2)(K) of the

FWPCA; and

(2) The State or interstate agency responsible for the preparation of a plan pursuant to an approved continuous planning process under Section 303(e) of the FWPCA, unless such agency is under the supervision of the Director.

§146.28 Public Hearings On Existing and New Underground Injections.

(a) The Director shall provide an opportunity for the applicant, any affected State, any affected interstate agency, any affected country, the Regional Administrator, or any interested agency, person, or group of persons to request an informal public hearing with respect to a UIC permit application.

(b) The Director shall hold an informal public hearing on a permit application if he finds there is a significant public interest (including the filing of requests or petitions for such a hearing) in holding such a hearing. Any hearing held under this subsection shall be held in the geographical area of the injection or proposed injection, and may, as appropriate, consider related groups of permit applications.

§146.29 Public Notice of Hearings On Existing and New Underground Injections.

(a) Public notice of any hearing held under Section 146.28 shall be circulated at least as widely as was the notice of the UIC permit application and shall be given at least 30 days prior to the hearing date.

(b) The contents of the public notice of any hearing held under Section 146.28 shall include at least the following:

(1) A brief description of the nature and purpose of the hearing, including rules and procedures to be followed;

(2) Name and address of the applicant whose application will be considered at the hearing;

(3) Name of formation into which injection is proposed, the injection depth, and a description of the location of the injection;

(4) A description of the fluid to be injected and the rate and pressure of injection;

(5) Nature of the applicant's activities or operations which result in the fluid to be injected (e.g., municipal waste treatment plant, steel manufacturing, drainage from mining activities);

(6) The date, time and location of the hearing;

(7) A concise statement of the issues raised by the person

requesting the hearing; and

(8) Name of the Agency holding the public hearing with address and phone number at which interested persons may obtain further information.

§146. 30 Director Action on UIC Permit Applications.

After considering the application for a permit for a new or existing underground injection and all pertinent matters relative thereto, if the Director finds that the applicant has demonstrated that the proposed well injection will not endanger underground drinking water sources, the Director may issue a permit. If the Director finds that the applicant has not demonstrated that the proposed well injection will not endanger underground drinking water sources, the Director shall issue a permit under Section 146. 21(a)(3). The Director's decision shall be in writing, and a copy furnished to the applicant.

§146. 31 Prohibited Underground Injection.

The Director shall insure that no permit shall be issued authorizing underground injection unless the applicant can demonstrate to the satisfaction of the Director that such injection will not endanger underground drinking water sources.

§146. 32 Permit Conditions and Other Requirements.

State procedures must insure that the terms and conditions of each issued UIC permit comply with the following:

(a) Adherence to any applicable more stringent limitations including those (i) necessary to meet both treatment standards and schedules of compliance, established under State law or regulation, or (ii) necessary to meet other Federal law or regulation;

(b) Allowance of no underground injection of contaminants until after:

(1) The use of appropriate techniques for construction, operation and maintenance of the injection system; and

(2) Provisions for inspection, monitoring, record-keeping and reporting of the underground injection operation;

(c) Allowance of no contaminant to enter an existing or potential underground drinking water source if the presence of such contaminant may endanger such drinking water source;

(d) Adequate contingency plans to cope with malfunctions or failure of the underground injection system;

(e) Adequate procedures for detecting failure of the system in a timely fashion;

(f) Provisions for such measures as the Director finds necessary to assure the availability of adequate financial resources for dealing with underground injection systems which either are improperly abandoned or may otherwise cause contamination of underground drinking water sources;

(g) That all injections authorized by the UIC permit shall be consistent with the terms and conditions of the permit and that the injection of any contaminant at a greater rate or pressure than that authorized by the permit, or a volume in excess of that authorized by the permit shall constitute a violation of the terms and conditions of the permit;

(h) That the permit may be modified, suspended, or revoked in whole or in part during its term for cause including but not limited to, the following:

   (1) The underground injection endangers underground drinking water sources;

   (2) Violation of any material terms or conditions of the permit;

   (3) Obtaining a permit by misrepresentation or failure to disclose fully all relevant facts; or

   (4) A change in any condition that may indicate failure of the underground injection system;

(i) That the permittee shall allow the Director or his authorized representative, upon the presentation of appropriate credentials:

(1) To enter the permittee's premises in which a contaminant source or injection system is located and in which any records are required to be kept under terms and conditions of the permit;

(2) To have access to and copy records required to be kept under terms and conditions of the permit;

(3) To inspect the permittee's facilities, including any monitoring equipment or analytical devices; and

(4) To sample any fluids being injected, and if sampling of the injection zone and other aquifers is required by the permittee under the monitoring plan of the permit, to also have the right to sample those zones;

(j) That the permittee at all times shall maintain in good working order and operate efficiently facilities or systems of control installed by the permittee to achieve compliance with terms and conditions of the permit.

(k) That immediately following the permanent cessation of underground injection or where a well is not completed, the permittee shall notify the Director and follow the procedures prescribed by the Director for plugging and abandonment; and

(l) That the permittee shall submit reports of all remedial work actions to the Director.

§146.33 Monitoring and Record-keeping.

Each permittee shall keep on forms prescribed by the Director complete and accurate records of:

(a) All monitoring required in the permit which will include, but not be limited to:

  (1) Weekly readings of the surface injection pressure;

  (2) Weekly readings of the tubing - long string annulus pressure;

  (3) Weekly total volume of injected fluid; and

  (4) Weekly average injection volume (bbls/day) (liters/day);

(b) All periodic well tests, including but not limited to;

  (1) Water analyses;

  (2) Measured or calculated bottom hole pressure readings of the injection zone;

  (3) Well conditions;

(c) All shut-in periods, times contingency measures used for handling the fluid to be injected;

(d) The permittee shall retain, for a period of five years, records of all information resulting from any monitoring activities required by the UIC permit or by regulation. This requirement shall continue in effect during the five year period following abandonment of the well. The period of retention shall be extended when requested by the Director; and

(e) Records of monitoring activities and results shall include for all samples; (1) the date, place and time of sampling; (2) the dates analyses were performed; (3) who performed the analyses; (4) the analytical techniques/methods; and (5) the result of such analyses.

§146.34 Reporting Requirements.

(a) Each permittee shall submit at least the following reports or notification to the Director on forms prescribed by the Director:

- (1) Notification of the initial injection operation within ten days of the start-up date; and
- (2) Quarterly reports which contain the data records required by the Director.

(b) Within ten days after the temporary discontinuance of disposal operations, the permitee shall notify the Director of the date and length of such discontinuance and the reason therefor. The Director will prescribe appropriate procedures to insure that underground drinking water sources are protected.

SUBPART D - REQUIREMENTS APPLICABLE TO INJECTION WELLS RELATED TO OIL AND GAS PRODUCTION

§146.40 Underground Injections to Which Subpart Applies.

This subpart sets forth requirements for State programs with respect to the underground injection of brine or other fluids which are brought to the surface in connection with oil or natural gas production; and underground injection for the secondary or tertiary recovery of oil or natural gas.

§146.41 Review of Existing Underground Injections.

(a) Underground injections which were in operation under approval by the Director under an existing State program before the approval of the proposed State program under Section 1422(b) of the Act may, for a period of up to five years, after approval, be regulated by rule provided such underground injections will not endanger underground drinking water sources.

(1) The Director shall obtain data necessary to make the determinations required under Section 146.42.

(2) The Director shall systematically review such underground injections to determine that they do not endanger underground drinking water sources. The approach for review may be by county, field, age of well or other systematic approach decided upon by the Director.

The method of review to be used must be indicated in the program submission to EPA along with a time schedule to assure that all existing underground injections will be reviewed within five years.

(3) Underground injections reviewed by the Director that do not endanger underground drinking water sources may continue operation under a permit issued in compliance with Sections 146.42 and 146.47.

(4) Underground injection operations that are found to endanger underground drinking water sources shall discontinue operation pending remedial action unless the Director determines that it is unreasonable or impracticable to discontinue operating pending remedial action. If the Director permits an endangering operation to continue pending remedial action the Director shall prescribe a compliance schedule which shall require remedial action to be taken as soon as practicable but in no case later than one year following the determination of endangerment.

(b) Pending review by the Director, underground injections must comply with State rules in effect on the date of proposal of the program, by the State.

(Note: Comment is solicited on the practicality and impact of this regulatory approach.)

§146.42 Requirements for Existing and New Underground Injections.

(a) The Director shall review data on existing underground injection and on proposed new underground injections to assure that:

(1) All underground drinking water sources of 3,000 mg/l total dissolved solids or less are protected by surface casing cemented to the surface;

(2) Injection is maintained through tubing with a suitable packer set immediately above the injection zone;

(3) The long string is cemented with sufficient cement to assure no migration of injected fluid above or below the injection zone;

(4) There are no leaks in the system;

(5) Surface injection pressure is limited to preclude the possibility of fracturing the confining strata;

(6) All well completion and plugging reports for wells of record penetrating the proposed injection zone within a one-half mile radius of the proposed well injection have been thoroughly reviewed to insure that all wells are properly completed and/or plugged that in the judgment of the Director present a

potential threat to underground drinking water sources; and

(7) Annular injection between the casing and hole is not practiced.

(8) Annular injection between strings of casing and between tubing and casing is not practiced; except that in specific cases the Director may approve such annular injection providing: (i) there is an annulus between the outer string of casing receiving the injection and the surface casing which can and will be monitored for leaks; (ii) that the surface casing is protected by cement to the surface; and (iii) that the injector demonstrates to the satisfaction of the Director that the injection will not endanger underground drinking water sources.

(9) Annular injection between the surface casing and the next innermost casing or between the surface casing and the tubing, or injection through the surface casing only, is not practiced; except that in specific cases the Director may approve such injection where: (i) the injection was in operation prior to approval of the proposed State program, and; (ii) the injector demonstrates to the satisfaction of the Director that, based on previous history and presentation of compelling evidence collected through fluid injection

profile surveys and/or monitoring wells that the injection has not endangered underground sources of drinking water, nor will continued use endanger underground sources of drinking water.

(b) The Director may designate specific areas in the State where an alternative method of protection to those required in (a)(1) and (a)(2) above has been used and has been demonstrated to be equally effective in the prevention of endangerment to underground drinking water sources provided:

(1) A complete record of all evidence, as well as all analyses of such evidence relative to a designation under this paragraph is submitted to the Administrator upon submission of the State program under Section 1422(b) of the Act.

(2) All injection wells located in the designated area and the alternative to be used are identified as a part of the submission to the Administrator.

Such designations are subject to the approval of the Administrator and the public hearing requirements of Section 146.10(g) and 146.14(a). If an area is to be designated after approval of the State program the procedure contained in this paragraph must be followed.

(c) The Director may approve an alternative method of protection for a specific well or injection in lieu of those required in (a)(1), (a)(2), (a)(3) provided:

(1) The injector can demonstrate to the Director with written compelling evidence that that specific requirement would interefere with or impede oil and gas production from the production well(s) serviced by that specific injection well;

(2) The injector can demonstrate to the Director with written compelling evidence that that specific requirement is not essential to prevent endangerment to underground drinking water sources resulting from that specific injection;

(3) The injector provides a written assessment of the alternative method of protection to be used; and

(4) The Director provides the opportunity for informal public hearing on that specific well or injection. (Note: Comment is solicited on the adequacy of these requirements in preventing endangerment to underground drinking water sources, and of the impact on existing wells.)

§146.43 Public Notice of Proposed Issuance or Denial of UIC Permits for Existing and New Underground Injections.

(a) The Director shall give public notice of the intent to issue or deny UIC permits for those existing and new underground injections reviewed under Section 146.41 and Section 146.47. The public notice may contain more than one underground injection facility. The approach may be similar to that in § 146.41 (a)(3). The public notice shall be circulated in a manner designed to inform interested persons of the proposed injection and of the determination to issue or deny a UIC permit for the proposed injection. Procedures for the circulation of public notices shall include at least the following:

(1) Notice shall be circulated within the geographical area of the proposed injection by publication in a local newspaper of general circulation;

(2) Notice shall be mailed to any person or group upon request;

(3) The Director shall provide a period of not less than 30 days following the date of the public notice, during which time interested persons may submit written comments regarding the determination to

issue or deny the UIC permit for an existing underground injection. All written comments submitted during the 30 day comment period shall be retained by the Director and considered in the formation of his final determination with respect to the UIC permit application.

(4) The Director shall provide a period of not less than 14 days following the date of the public notice, during which time interested persons may submit written comments regarding the determination to issue or deny the UIC permit for new underground injections. All written comments submitted during the 14 day comment period shall be retained by the Director and considered in the formation of his final determination with respect to the UIC permit application.

(b) The contents of public notice of issuance or denial of UIC permits shall include at least the following:

(1) Ownership and location data

  (i) Operator of injection well or project; and

  (ii) Location by geographic area, or section, township, and range.

(2) Engineering Data

(i) Purpose of Injection (Disposal, Recovery);

(ii) Estimated volume and type of fluid to be injected (by lease, pool, field or other suitable means); and

(iii) Number of injection wells.

(3) Depth and geologic name of the injection zone or formation;

(4) A statement of the Director's determination to issue or deny the permit and a brief description of the procedures for the formulation of final determinations, including the comment period and any other means by which interested persons may influence or comment upon those determinations; and

(5) Name of the State Agency issuing the public notice with address and phone number at which interested persons may obtain further information, and inspect and copy UIC application forms and related documents.

§146.44 Notice to Other Government Agencies.

The Director shall also notify other appropriate government agencies of the proposed issuance of a UIC permit and shall provide such agencies an opportunity to submit their written views and recommendations or request a public hearing. Procedures for such notification shall include the following:

(a) At the time of issuance of public notice under §146.43, a copy of the notice will be transmitted to the Director in any other State or Territory whose waters may be affected by the issuance of a UIC permit and, upon request, such State will be provided with a copy of the UIC permit application and a copy of the proposed permit. Each potentially affected State or Territory may submit written recommendations to the Director (with copies to the Regional Administrator(s) for the potentially affected Region(s)). The Director shall provide the affected State or States (and the Regional Administrator(s)) a written explanation of his reasons for failing to accept any such written recommendations;

(b) A procedure, similar to paragraph (a) of this section, for notifying any interstate agency or commission having ground-water quality control authority over waters which may be affected by issuance of a permit; and

(c) A procedure for mailing a copy of the public notice of an application for a UIC permit to any other Federal, State, or local agency, or any foreign country, upon request, and providing an opportunity to respond, comment, or request a public hearing under Section 146.46. Such agencies shall include at least the following:

(1) The agency responsible for the preparation of an approved plan under Section 208(b)(2)(K) of the FWPCA; and

(2) The State or interstate agency responsible for the preparation of a plan pursuant to an approved continuous planning process under §303(e) of the FWPCA, unless such agency is under the supervision of the Director.

§146.45 Public Hearings on Existing and New Underground Injections.

(a) The Director shall provide an opportunity for the applicant, any affected State, any affected interstate agency, any affected country, the Regional Administrator, or any interested agency, person, or group of persons to request an informal public hearing with respect to a UIC permit application.

(b) The Director shall hold an informal public hearing on a permit application if he finds there is a significant public interest (including the filing of requests or petitions for such hearing) in holding such a hearing. Any hearing held under this subsection shall be held in the geographical area of the injection or proposed injection, and may, as appropriate, consider related groups of permit applications.

§146.46 Public Notice of Hearings on Existing and New Underground Injections.

(a) At least 14 days prior to a public hearing held under Section 146.45, the Director shall give notice of such hearing by publication in a newspaper of general circulation within the geographical area of the proposed injection and shall set forth the following:

(1) Ownership and location data

(i) Operator of injection well or project; and

(ii) The location of the injection well or project by section, township and range, or by a location from the nearest village or town, or in such other manner as will identify the geographical area involved.

(2) Engineering Data

(i) Purpose of injection (disposal, recovery);

(ii) Volume and type of fluid to be injected; and

(iii) Number of injection wells involved;

(3) Depth and geologic name of the injection zone or formation;

(4) A concise statement of the issues raised by the person requesting the hearing;

(4) The name of the agency issuing the notice and the date, time, and location of the hearing;

(b) The Director shall further supply the information set out above to each State, interstate or Federal agency and to each person or group of persons expressing an interest in the permit to be considered at a hearing.

§146.47 Application for UIC Permit for a New Underground Injection. An application for a UIC permit for a new underground injection shall be filed with the Director on forms prescribed by the Director.

(a) The application form for any new underground injection shall include the following:

(1) Ownership and Location Data

The application shall identify the owner and operator of the proposed underground injection facility, and the location of the facility;

(2) Engineering Data

(i) A detailed casing and cementing program, or a schematic showing: diameter of hole, total depth of well and ground surface elevation; surface, conductor, and long string casing size and weight, setting depth, top of cement, method used to determine top; tubing size, and setting depth, and method of completion (open hole or perforated);

(ii) A map showing name and location of all producing wells, injection wells, abandoned wells, dry holes, and water wells of record within a 1/2 mile radius of the proposed injection well; and

(iii) A tabulation of all wells requested under (ii) penetrating the proposed injection zone, showing: operator; lease; well number; surface casing size and weight, depth and cementing data; intermediate casing size and weight, depth and cementing data; long string and weight, depth and cementing data; and plugging data.

(Note: Comment is solicited on other ways to demonstrate non-endangerment from wells penetrating the proposed injection zone where it is possible that the wells may be an open connection to an underground drinking water source.)

(3) Operating Data

(i) Depth to top and bottom of injection zone;

(ii) Anticipated daily injection volume, minimum and maximum, in barrels;

(iii) Approximate injection pressure; and

(iv) Type, source and characteristics of injected fluids.

(4) Geologic Data - Injection Zone

Appropriate geologic data on the injection zone and confining beds including such data as geologic names, thickness and areal extent of the zone.

(5) Underground Sources of Drinking Water Which May be Affected by the Injection Including:

Geologic name and depth (below land surface) of aquifers above and below the injection zone containing water of 3,000 mg/l total dissolved solids or less, and aquifers containing water of 10,000 mg/l total dissolved solids or less.

(6) An electric log on all new wells and on existing wells where available.

(b) The Director may request any of these additional data necessary to make the determinations required in Section 146.41.

(1) Engineering Data

  (i) Method to determine rate of corrosion;

  (ii) Cement bond log;

  (iii) List of all cement squeeze operations, giving interval and number of sacks of cement;

(2) Operating Data

  (i) Whether open or closed system;

  (ii) Contingency plans to cope with all shut-ins or well failures;

(3) Geologic Data - Regional Structure

Location, extent and effects of known or suspected faulting, indicating whether faults are sealed or fractured avenues for fluid movement;

(4) Underground Sources of Drinking Water

Lithology of aquifers defined as underground sources of drinking water;

(5) Any surface retention facilities associated with the injection operation;

(6) Reservoir and Fluid Data on Entire Reservoir

  (i) Lithology;

  (ii) Original and current bottom hole pressure;

(7) Reservoir and Fluid Data on Lease

  (i) Average horizontal permeability;

  (ii) Average porosity;

(8) Production history of reservoir;

(9) Type of injection project and results expected; and

(10) Injection pattern and spacing.

§146.48 Permit Conditions and Other Requirements.

State procedures must insure that the terms and conditions of each issued UIC permit including each permit for an existing underground injection, comply with the following:

(a) Adherence to any applicable, more stringent limitations including those (i) necessary to meet treatment standards, or schedules of compliance, established pursuant to State law or regulation, or (ii) necessary to meet other Federal law or regulation;

(b) Allowance of no underground injection of contaminants until after:

  (1) The use of appropriate techniques for operation and maintenance of the injection system; and

  (2) Provisions have been completed for inspection, monitoring, recordkeeping and reporting of the underground injection operation;

(c) Allowance of no contaminant to enter an underground drinking water source if the presence of such contaminant may endanger such drinking water source;

(d) Adequate contingency plans to cope with malfunctions or failure of the underground injection system;

(e) Adequate procedures for detecting failure of the system in a timely fashion;

(f) Provisions for such measures as the Director finds necessary to assure the availability of adequate financial resources for dealing with underground injection systems which either are improperly abandoned or may otherwise cause contamination of underground drinking water sources;

(g) That all injections authorized by the UIC permit shall be consistent with the terms and conditions of the permit and that the injection of any contaminant at a greater rate of pressure than that authorized by the permit, or a volume in excess of that authorized by the permit shall constitute a violation of the terms and conditions of the permit;

(h) That the permit may be modified, suspended, or revoked in whole or in part during its term for cause including but not limited to, the following:

(1) The underground injection endangers underground drinking water sources;

(2) Violation of any material terms or conditions of the permit;

(3) Obtaining a permit by misrepresentation or failure to disclose fully all relevant facts; or

(4) A change in any condition that may indicate failure of the underground injection system;

(i) That the permittee shall allow the Director or his authorized representative, upon the presentation of appropriate credentials:

(1) To enter permittee's premises in which a contaminant source or injection system is located and in which any records are required to be kept under terms and conditions of the permit;

(2) To have access to and copy records required to be kept under terms and conditions of the permit;

(3) To inspect the permittee's facilities, including any monitoring equipment or analytical devices; and

(4) To sample any fluids being injected and if sampling of the injection zone and other aquifers is required by the permittee under the monitoring plan of the permit, to also have the right to sample these zones;

(j) That the permittee at all times shall maintain in good working order and operate efficiently the facilities or systems of control installed by the permittee to achieve compliance with terms and conditions of the permit;

(k) That immediately following the permanent cessation of underground injection or where a well is not completed the applicant shall notify the Director and follow the procedures prescribed by the Director for plugging and abandonment; and

(l) That the permittee shall report all remedial work to the Director.

§146.49 Monitoring and Record-keeping.

Each permittee shall keep on forms prescribed by the Director complete and accurate records of:

(a) All monitoring required in the permit which will include, but not be limited to:

(1) Weekly readings of the surface injection pressure;

(2) Weekly readings of the tubing - long string annulus pressure;

(3) Weekly total volume of injected fluid; and

(4) Weekly average injection volume (bbls/day). (liters/day);

(b) All periodic well tests, including but not limited to:

(1) Water analyses; and

(2) Well conditions;

(c) The permittee shall retain, for a period of five years, records of all information resulting from any monitoring activities required by the UIC permit or by regulation. This requirement shall continue in effect during the five-year period following abandonment of the well. The period of retention shall be extended when requested by the Director; and

(d) Records of monitoring activities and results shall include for all samples; (1) the date, place and time of sampling; (2) the dates analyses were performed; (3) who performed the analyses; (4) the analytical techniques/methods; and (5) the results of such analyses.

146.50 Reporting Requirements.

(a) Each permittee shall submit at least the following reports or notification to the Director on forms prescribed by the Director:

(1) Notification of the initial injection operation within ten days of the start-up date; and

(2) Quarterly reports which contain the data records required by the Director.

(b) Within ten days after the temporary discontinuance of disposal operations the permittee shall notify the Director of the date and length of such discontinuance and reason therefore. The Director will prescribe appropriate procedures to insure that underground drinking water sources are protected.

SUBPART E - REQUIREMENTS APPLICABLE TO ALL DRAINAGE WELLS

§146.70 Underground Injections to Which Subpart Applies.

This subpart sets forth requirements for State programs with respect to drainage wells used to dispose of stormwater run-off and irrigation return flow. Underground injections covered by this subpart include injections to dispose of storm water runoff, irrigation return flow, and excess ponded surface waters.

§146.71 Regulation by Rule or Permit.

A State program may regulate any category of underground injection covered by this subpart by rule or by permit system, at the option of the State.

§146.72 Regulation by Permit.

If a State elects to regulate a category of underground injection covered by this subpart by permit, the permit requirements must include, as a minimum:

(a) That the applicant for the permit to inject must provide such information as the State may require regarding location and design of the facility, nature and volume of the fluid to be injected, and such other information as may be necessary to satisfy the State that the underground injection will not endanger underground drinking water sources.

(b) That the Director will give public notice and provide opportunity for comment and informal public hearing in cases where the Director determines that the application raises substantial question of possible endangerment of underground drinking water sources.

(c) That permits issued will be conditioned on compliance with specified inspection, monitoring, record-keeping and reporting requirements.

§146.73 Regulation by Rule.

If a State elects to regulate a category of underground injection covered by this subpart by rule, the State regulations applicable to that category shall provide, but not be limited to, the following:

(a) That no underground injection that endangers underground drinking water sources is authorized;

(b) A mechanism for determining the nature and extent of the underground injection activity in the State;

(c) A mechanism for insuring that periodic testing is conducted and test records are maintained in appropriate cases; and

(d) That design, location or construction of underground injection facilities that would be inconsistent with good practice for the protection of underground drinking water sources is prohibited.

§146.74 Remedial Action.

(a) Underground injection operations that are found to endanger underground drinking water sources shall discontinue operation pending remedial action unless the Director determines that it is unreasonable or impracticable to discontinue operating pending remedial action. If the Director permits an endangering operation to continue pending remedial action the Director shall prescribe a compliance schedule which shall require remedial action to be taken as soon as practicable but in no case later than one year following the determination of endangerment.

ECONOMIC ANALYSES
STATE UNDERGROUND INJECTION CONTROL PROGRAM
PROPOSED REGULATIONS

Proposed State Underground Injection Control Program

Costs and Economic Impacts

Table I following summarizes our best estimate of the capital expenditures required for existing underground injection and disposal wells by regulations. To this total of $225 million a figure of approximately $1 million per year would be required for permit applications and remedial actions associated with new wells.

The estimated annualized costs of the proposed regulations are presented in Table II. These total approximately $74 million.

Table 1

Proposed State Underground Injection Control Program

Estimated Capital Expenditures- Existing Wells (1976-1986)

($ million)

Type of Well	Number	Capital Expenditures
Industrial-Municipal Disposal Wells		
Industrial	264	
Municipal	20	1.3
Shallow Disposal Wells		
Industrial - Municipal	2,000	150.0
Subsidence Control Wells	500	0.25
Barrier Wells	100	0.05
Recharge Wells	200	0.10
Gas Storage	14,500	1.45
Geothermal Wells	10	----
Solution Mining Wells	500	0.38
Oil and Gas Industry Injection Wells	70,000	19.0
Drainage Wells	50,000	52.5
TOTAL (Rounded)	138,000	$225

TABLE II

Proposed State Underground Injection Control Program

Estimated Annualized Costs

($ Million)

	Costs Annualized
Annualized Costs Associated with Capital Expenditures	
Capital Items:	
with Operating and Maintenance Costs (1)	$61. 1
without Operating and Maintenance Costs (2)	4. 3
Other Annualized Costs	
Annual Costs of Waste Water Disposal from Oil and Gas Wells Currently Practicing Annular Injection	0. 7
Additional Annual Costs of State Program Administration	7. 3
Additional Annual Costs of Federal Program Administration	0. 8
Total Annualized Costs	$74. 2

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1) Includes $203. 5 million of capital expenditures for waste water treatment facilities, monitoring facilities, etc. (See Text for Details). An annualization rate of 30% is used, 15% for operating and maintenance and 15% for capital costs and other annualized costs. These figures were chosen because they allow for a comfortable margin over the 12. 45% and 11. 58% calculated for industrial waste water treatment facilities in The Economics of Clean Water - 1973; U. S. Environmental Protection Agency; 1973; p. 37.

2) Includes $21. 4 million of capital expenditures for permit application and the plugging of abandoned wells. An annualization rate of 20% is used, because most of these expenditures ($19 million) are from the oil and gas industry in which a shorter facility life-time (10 years) is more appropriate.

In general it should be noted that the available information is minimal for many of these categories of wells. Consequently, much of the economic analysis must be based upon professional judgments as to the number of existing wells, the portion that may require remedial action, etc. In this report we have tried to be conservative in our estimates. For this reason the costs presented below may substantially exceed actual expenditures. In the time remaining before promulgation of these regulations we will make every effort to obtain additional information, so that these estimates may be as accurate as possible.

The majority of the estimated costs are for three categories: (1) plugging abandoned oil and gas wells; (2) eliminating the estimated 2,000 shallow municipal and industrial waste water disposal wells; and, (3) remedial actions on a small portion of the estimated 50,000 drainage wells. The estimated costs for the remaining categories are low, because almost all of these wells are judged to be well engineered and well operated so that no remedial action will be required.

Little or no economic impact is expected from these regulations either in terms of increased prices or plant shutdowns, not only because the costs are relatively low, but also because they will be spread over a period of at least five years as the States collect information and assess the nature of the problem.

The unit costs to the oil and gas industry for plugging abandoned wells are judged to be low and are not expected to create any economic dislocations. The elimination of shallow wells may create some economic problems, but since these wells are already prohibited by existing State regulations, their distribution and ownership is not known. The net effect of their elimination, however, will be simply to enforce the existing State regulations and the Federal effluent limitation guidelines. The costs of remedial actions on some of the drainage wells may be high, but these instances should be few and should be mitigated by the flexibility included in the State rule-making procedures.

The following sections present more detail on our economic analysis for each category of wells.

Injection Wells Related to Oil and Gas Production

Injection wells used by the oil and gas industry for disposal of water or for secondary recovery of product by water flooding are estimated to total approximately 70,000. This figure is based upon recent information obtained by EPA which shows a total of about 40,000 secondary recovery wells and 8,000 brine-disposal wells in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. We have estimated that 20,000 secondary recovery wells and 2,000 brine disposal wells exist in the remaining States. Approximately 5,000 new wells are drilled each year.

In our analysis of the economic impacts of these regulations upon the oil industry we have examined first the economics of production of various segments of the oil producing industry. A description of these segments and an illustrative summary of average revenues, costs, and production characteristics for wells in each segment is provided in Section A.

The major costs to the oil and gas industry imposed by these regulations are expected to be those associated with: (1) permit applications; (2) plugging of abandoned wells; and (3) cessation of water injection between the annulus of the surface pipe and the production string.

Most states now control new injection wells by permit and require detailed information about the site, the proposed disposal formation and the characteristics of the injection. Records of all wells are maintained, although the data may become incomplete further back than the 1930's. It is our analysis that the States will require additional information on some of the existing applications. Accordingly, we have assumed a $100 average cost for all existing permit applications. This results in a total cost of $7 million for existing wells and $0. 5 million per year for new wells.

The proposed regulations require that all wells penetrating the injection zone within a one-half mile radius of the injection or disposal wells are properly completed and/or plugged that in the judgment of the State present a threat to underground drinking water sources. Half of the oil producing states already have a requirement similar to this. Based upon our best professional judgment we have estimated that the plugging requirements associated with the regulation will result in the remedial plugging of no more than one abandoned well for every thirty existing injection or disposal wells. * The average costs of these pluggings would be about $5,000 per well plugged** or about $167 per injection well. The total national costs of this program would be about $12 million for existing wells and about $0.8 million per year for new wells.

To assess the impact of the application and plugging expenditures discussed above, we have estimated the average annual costs of these expenditures per barrel of oil produced, and have compared these costs with our estimates of the average annual costs and revenues associated with oil production. The details of this analysis are presented in Section A. This analysis shows that the annual costs associated with the application and plugging requirements are less than one and one-half cents per barrel of oil produced. In none of the industry segments studied do these costs exceed 0.4 percent of the estimated gross margin of the producing wells.

Costs of this magnitude are not considered to be significant. Furthermore, the total national costs of about $19 million over several years for existing wells and about $1.3 million per year for new wells are not significant when compared with the oil industry's $4 billion annual capital budget. We, therefore, expect the impact of this portion of the regulations on oil production to be negligible.

State regulations now permit the injection of water in the annulus of the surface pipe and the production string only with the special permission of the appropriate authority. Consequently, the practice is rare in most states. In a few States, most notably Ohio, Louisiana and Arkansas, this practice is more common. However, the total number of wells involved is small, less than 2,000, and the total cost of disposing of the producted water, approximately $730,000 per year, is insignificant on a national basis. The additional cost to operators of $1 per barrel of oil to dispose of this water will not seriously impair the profitability of oil wells. Thus, the number of oil wells that might be shut down because of the prohibition of annular injection is not likely to be significant even on a regional basis. The details of this analysis are presented in Section A.

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* It should be noted that this estimate is to be regarded as illustrative only, and is provided to give an indication of what the possible magnitude of these costs could be. It is not anticipated that any impact of this order of magnitude will actually result.

** Based upon studies showing plugging costs varying from $1,500 to $14,000.

The requirement that surface casing extend through 3,000 mg/l total dissolved solids water is not seen as adding significantly to capital costs; it would not be practical to add additional surface casing.

Gas production compliance costs were not estimated using the methodology employed for oil production. However, the data developed in that analysis can be used to demonstrate that the economic impact of gas production compliance will be very small. There is no secondary recovery for gas production, as there is in oil. Thus, as a first step, compliance costs will be no higher for gas than for primary oil production -- about .07 cents/bbl. (0.1 cents/MMBTU). Second, the average gas flow from wells is greater than the average oil flow. If we estimate average oil flows at 30 bbl/day and average gas flows at 70 bbl/day equivalent, then the compliance costs become 0.005 cents/MMBTU. Third, the water production is "insignificant." Even if we assume that water production from gas wells is as much as one-half that of oil wells, the ceiling on compliance costs is still lowered to 0.0025 cents/MMBTU.

These compliance costs are insignificant compared to gas selling prices. If and when natural gas prices are deregulated, prices may rise to $1.50 to $2.00 per MMBTU. Compliance costs would then represent less than .002% of selling price. If prices are not deregulated, it is likely that compliance costs would be entered into the rate base, effectively negating any impacts on marginal producers.

Municipal and Industrial Injection Wells

A recent EPA survey has identified 383 permitted industrial and municipal waste injection wells in the United States. Of these, 322 have been drilled and approximately 264 industrial and 20 municipal wells are currently operating or available for operation. The remainder are either plugged or have not yet been drilled. The approximate distribution of the permitted wells by industrial category is presented in Table B-1.

TABLE III

Proposed State Underground Injection Control Program
Estimated Capital Expenditures - 322 Existing Municipal and Industrial Injection Wells

Action	Key Assumptions	Unit Costs	Percentage of Wells Requiring Action	Total Capital Expenditures ($ Thousands)
Permit Application	All necessary information is already available. Processing requirements are minimal.	$ 500	100%	$161
Monitoring	For wells where action is necessary, one shallow monitoring well into the first fresh water aquifer will be required.	5,000	5%	80
Stand-by Facility	Complete contingency coverage is provided by drilling a new injection well to use as stand-by.	250,000	1%	800
Plugging	1-1/2 abandoned wells must be plugged for every well located in a problem area.	5,000	10%	161
Drill Deeper Reduce Pressure, etc.	Some wells will be drilled 1,000 ft deeper at $16/ft. - no other actions will be necessary.	16,000	1%	51
Bonding	No information about possible bonding costs has been obtained.	Not available	100%	Not available

NOTE: More information on the derivation of these estimates is provided in Section B.

Possible costs that might be associated with these regulations include: (1) application costs, i.e. the costs associated with collecting the additional necessary geological and other information required to apply for a permit; (2) the costs of increased monitoring capability; (3) the costs associated with having an adequate contingency plan; (4) the costs of plugging nearby abandoned wells; (5) the costs of remedial actions such as drilling existing wells deeper, reducing injection pressure, or repairing construction deficiencies; and (6) the costs of meeting bonding requirements.

Because injection wells generally discharge large volumes of wastes which are often highly toxic and which will persist indefinitely in the subsurface environment, State authorities have in almost every case insured that the existing wells are well engineered and adequately operated. Consequently very few additional costs are expected to be associated with these regulations. However, it seems likely that as a result of the permitting process some remedial action will be necessary for a few wells. Just how many wells are likely to be deficient in that respect is impossible to determine. Accordingly, we have included in our analysis estimates of the unit costs that are likely to be involved and of the percentage of wells that might, in our judgement, have to take remedial action.

Table III summarizes our estimates of the additional capital expenditures for municipal and industrial operators of injection wells associated with these regulations. These total $1.1 million for the 284 wells now operable. Because the requirements of the regulations are not essentially different from current requirements in most States, no additional capital expenditures are assumed for new injection wells.

The economic impact of these additional expenditures is expected to be minor. Most of the costs are very low when compared to the original costs of most facilities*, or with the $250,000 assumed average cost of a new facility. Although the cost of building a new stand-by well could be large, such a facility will not be built unless the economic situation of the operator can justify it. Otherwise, a much less expensive option will be chosen, or the operator will simply choose shutting down his plant as the required contingency plan. These plants will choose simply to operate until their existing well fails--an event whose probable occurence is not affected by these regulations. The only operations for which plant shut down would not be a viable option would be the municipalities, to whom federal grants are available for seventy-five percent of any required capital expenditures.

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* These range from $30,000 to $1,400,000. See Donaldson, E.C.; Subsurface Disposal of Industrial Wastes in the United States; Bureau of Mines, IC 8212; 1964

Shallow Municipal and Industrial Disposal Wells

Although the practice is clearly illegal in most States, a number of municipalities and industrial establishments still dispose of waste water by direct injection into fresh water aquifers through shallow wells. Because these wells are prohibited, their existence is not reported to State or Federal authorities. Hence, it is not possible to obtain any information on their number, size, ownership, or the nature of their wastes. Consequently, any estimate of the economic impact of these regulations upon operators of shallow disposal wells must necessarily be speculative.

Based upon the best available professional judgment we have estimated the number of municipal and industrial shallow disposal wells at 2,000.

Strict enforcement of these regulations will result in the total elimination of these shallow wells. Because most of the wells are located in areas where the subsurface geology would prevent drilling the wells deeper, the most likely disposal alternative will be to install conventional waste water treatment systems in conformance with the effluent limitation guidelines. It is our judgment that the wells handle relatively small volumes of waste water. For this reason we have estimated that most wells could easily be replaced by package treatment systems costing at most $75,000 including permit application, etc. This would result in total national capital expenditures for complying with these regulations of $150 million. It should be pointed out again that these estimates are to be regarded as illustrative only. It is not anticipated that any impact of this magnitude will actually occur.

The total costs are relatively small, and the unit costs should be manageable in most cases. For some establishments discharging particularly hard-to-treat wastes--such as electroplating wastes--the costs may be prohibitive. Thus, some plants may be forced to close. However, the total number of plant closings should be small with no significant concentrations in any industry or geographic area.

Because these shallow wells are prohibited already the net effect will be to enforce the effluent limitation guidelines that should have been met even without these regulations. Thus, any economic impact of these regulations upon operator of shallow disposal wells should already have been included in the economic impact analyses for the effluent limitation guidelines. It might even be argued that the incremental cost imposed by these regulations is zero, since no new prohibitions are being added to existing regulations.

Subsidence Control, Barrier, Recharge, Gas Storage and Geothermal Wells

To the best of our knowledge all of these wells are well engineered and well operated, and pose no threat to the ground water. Consequently, for these wells we have assumed that the only costs imposed by the regulations will be permit application costs of $500 per well. This estimate assumes that all of the information required to apply for a permit is readily available.

For gas storage wells we have assumed that the costs per well will be only $100. This is because the 14,500 wells are grouped in about 350 storage fields. Thus, most of these wells will be almost identical and the applications will contain the same information.

Solution Mining Wells

It is our estimate, based upon available data and professional judgement, that there are approximately 500 solution mining wells in the United States.

Almost all of these wells are subject to strict State controls and are known to be well engineered and well operated. However, it is possible that enforcement of these regulations may result in additional monitoring wells being required in some instances. We assume that were additional monitoring is necessary, two wells at a cost of $3,000 each would be installed.

Because most solution mining wells will not need to take any remedial action, these costs will apply only to a small fraction of the wells. In our judgement, five percent of the wells at most would be found deficient. Thus, a very conservative estimate of these capital expenditures would be $125,000 ($6,000 per well for 25 wells).

It is our judgment that all information necessary for permit applications should be on hand already for all solution mining wells. Thus, we have estimated that these wells would incur minimal permit application costs of $500 each, for a total of $250,000. The total capital expenditures for these regulations for operators of solution mining wells, therefore, would amount to $375,000.

The economic impact of these costs is not expected to be significant. The total costs for the industry are relatively low, and the unit cost that might be incurred by some operations seem manageable.

Drainage Wells

Although the use of drainage wells to handle the disposal of excess surface water is a fairly common practice, no studies are available to provide statistics on the number, distribution, size, etc. of these wells. Our best professional judgment is that there are about 50,000 of these wells.

It is our judgment that the States will choose to regulate these drainage wells by rule rather than permit. Once information on these wells has been collected and their potential threat to underground drinking water reviewed, - a process that should take about five years - it is not likely that remedial action will be required on more than a small percentage of these wells. Based upon the best professional judgment available we have estimated this percentage to be at most 2%.

Remedial action that might be appropriate for these wells would be site evaluation studies and, in some cases, treatment of the waste waters. In our estimation the study requirments for site evaluation would be about $2,500. The cost of treatment systems will vary. Since most drainage wells do not handle large volumes of water, the average costs of a treatment facility should be relatively low--about $50,000. Where the volume of water is large, and especially where it would have to be transported large distances for treatment, the costs would be considerally higher.

Using the estimates of 2% of all drainage wells requiring remedial action, and the average costs of this remedial action being about $52,500, the total capital expenditures for these renovations for operators of existing drainage wells would be about $52.5 million.

Since these costs will be spread over a number of years and a variety of agricultural and industrial producers as well as municipalities, it is not likely that they will have any noticeable inflationary impact. In localized cases, where the costs of required treatment systems are large, significant economic hardship might result. This will be especially true for independent agricultural establishments. However, we believe that the requirements of these regulations give the states sufficient flexibility so that the number of these instances will be minimal.

State Program Expenditures

The Safe Drinking Water Act provides for the States, upon EPA's approval, to assume primary enforcement responsibility for these proposed regulations. Section C presents our analysis of the possible annual costs to the States of administering the enforcement programs. Based upon our estimates of the number of permits that would have to be issued each year and our observation that most States are already making significant expenditures for similar programs, and using work load guidelines from studies that have been done of similar programs, we have estimated that the annual incremental costs of these proposed regulations for State programs would be at most $7.5 million. These expenditures would be shared by the Federal Government through State Grant Assistance.

Federal Program Expenditures

Increased expenditures by the Federal Government in administering these proposed regulations should be minimal. In addition to the personnel already working in this area, the Agency should not have to hire more than one or two additional personnel per region to oversee the State programs and to provide technical assistance. Assuming an annual cost of $40,000 per employee for salaries, overhead, etc., the total costs of these additional personnel should not exceed $800 thousand.

A few projects have been funded to study the feasibility of rehabilitating a brine polluted aquifer. Unfortunately, most of the rehabilitation methods studied were not technically sound, nor economically justified. A Study of one specific underground fresh water aquifer involving approximately one square mile of contamination, which would eventually spread to affect four and one-half square miles, and would remain for over 250 years before being flushed naturally into surface water, indicated that no positive public benefit-cost ratio could be developed.

Current cost to rehabilitate the four and one-half square mile affected area could involve expenditures in excess of $11,000,000 to rehabilitate the aquifer. Alternative methods, which are not always feasible, like use for secondary oil recovery, supplemental irrigation water, based on 40 to one dilution, etc. would still cost approximately $500,000 to $800,000.

Section A

Economic Analysis - Oil Wells

Industry Segments

An oil well cannot be economically described by using an industry-wide average. Both drilling costs and production costs vary greatly between fields and between wells. Consequently, segmenting the industry into representative sectors is a first step toward more precise and meaningful economic description. Listed across the top of Table A-1 are the industry segments which have been selected for study. A distinction is made between Southwestern wells and Appalachian wells because of the significant difference in operating costs between these two oil producing regions. It is believed that the segments included herein represent the extremes of the average industry-wide costs, and include the major industry segments which will be most impacted by these regulations.

A distinction is next made between new and existing production. For a new well, initial capital costs must be considered, because they have not yet been incurred. For an exisiting well, these costs have already been incurred and hence are "sunk." Rational economic decisions ignore sunk cost and consider only costs yet to be incurred when deciding whether an existing well will continue to operate. On the other hand, analysis of whether to drill a new well must consider initial capital costs. Hence, the capital cost of drilling and completing a new well is a positive number while the capital cost of an existing well is zero.

New production also differs from existing production in terms of revenue per barrel of oil. New production is uncontrolled and is assigned a revenue of $13 per barrel. Existing production currently is listed at the control price of $5. 25 per barrel, although this price may increase to uncontrolled levels in a short period of time.

Finally, a distinction is made between primary, secondary, and stripper production*. New and old primary production are good examples of segments containing both economically healthy and marginal production. The uncontrolled price and profit margin of new primary production indicate that only a small percentage of its production is

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* Tertiery production is not broken out separately.

TABLE A-1

ILLUSTRATIVE AVERAGE REVENUES AND COSTS PER SEGMENT

	SOUTHWEST					APPALACHIA
	New Primary	Existing Primary	New Secondary	Existing Secondary	Stripper	Stripper
Revenue Per Barrel	13.00	5.25	13.00	5.25	13.00	13.00
Costs						
Capital Costs Per Barrel	5.12	0	.51	0	0	0
Operating Costs Per Barrel	2.80	2.80	3.40	3.40	3.64	6.08
Royalties 1/	2.08	.84	2.08	.84	2.08	2.08
Taxes (severance and ad valorem) 2/	.82	.33	.82	.33	.82	.82
Total	10.82	3.97	6.81	4.57	6.54	8.98
Gross Margin	2.18	1.28	6.19	.68	6.46	4.02

[1] at 16% of revenue

[2] at 7.5% of revenue minus royalties

Source: FEA Oil Model, ICF, Inc.; National Stripper Well Survey; Enhanced Recovery Alternatives, Interstate Oil Compact Commission, Cost - Price Study of Producing Stripper Wells (John Pederson, National Stripper Well Association).

marginal. It should be noted, however, that the average existing primary well produces 15. 5 barrels per day over the life of primary production. A new primary well can be expected to produce on average something slightly less than 15. 5 barrels per day given recent finding and production figures. There are thus some low production wells in the primary segment that could be vulnerable to cost increases.

Secondary production differs economically from primary production in that while its initial producing well capital costs are sunk, some captial costs are associated with new production due to the need for water injection wells. Both new and old secondary production have higher operating costs than primary production because of water treatment and injection costs, and possible higher lifting costs.

Stripper production is, of course, old production and thus has no capital or finding costs. Stripper wells are defined to be wells producing less than 10 barrels per day.

Note the variation in gross margin between segments (see Table A-1). Further, recall that there are ranges within segments and that therefore some wells will perform much better or much worse than the average. Also note that the numbers in Table A-1 should be considered illustrative rather than precise estimates.

Production Characteristics

The average costs and revenues presented in Table A-1 have been calculated per barrel of oil. To convert these into annual costs and revenues, we have assigned the following average daily production figures to the industry segments.

TABLE A-2

Average Daily Production Per Segment *

	SOUTHWEST					APPALACHIA
	New Primary	Existing Primary	New Secondary	Existing Secondary	Stripper	Stripper
Average Daily Production Bbl	20. 2	20. 2	30	30	3	0. 7

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* These numbers come from the Federal Energy Administration Oil and Gas odel (1974), industry estimates, and the National Stripper Well Survey (1974)

To estimate the costs per producing well of regulations affecting injection or disposal wells, it is also necessary to estimate the average number of oil wells serviced by a disposal well for each of the segments. (Note: In this context we will use the term "disposal" to include water injection wells used in secondary recovery as well as those wells used strictly for water disposal.) Those estimates are given below.

TABLE A-3
Oil Well to Water Disposal Well Ratio Per Segment

	SOUTHWEST					APPALACHIA
	New Primary	Existing Primary	New Secondary	Existing Secondary	Stripper	Stripper
Oil Wells Per Brine Well	10	10	2	2	15	15

All of these numbers are very rough averages. The water/oil ratio as well as the proximity of surrounding wells can make the number for primary production vary from 1 to 70. In Appalachia, even though water disposal wells are rare, we have assumed one disposal well per fifteen producing wells merely for illustrative purposes. The average of two injection wells for each secondary recovery well is equally rough. In "peripheral" flooding, where old wells along the outside of the field are converted to injection wells, the number could be larger. The same would be true in a pressure maintenance program where a few injection wells are used in a field to keep the bottom hole pressure sufficiently high to maintain proper gas/oil ratio. On the other hand, the average of 2 to 1 could be too large for "pattern flooding" where injection wells surround a producing well.

Cost of Regulations

These figures provide us with a framework for analyzing the possible impact of the proposed regulations. The costs associated with permit applications and with remedial plugging requirements have been presented in the main text above as being $100 per disposal well for permit applications and $167 per disposal well for remedial plugging. The costs of disposing of produced water from wells which are currently injecting this water between the annulus of the surface pipe and the production string has been estimated at $1 per barrel of oil produced. The magnitude of these costs can be assessed by comparing these costs on an annualized basis with the annual costs and revenues of the producing wells.

Capital Expenditures

Because both permit application costs and the costs of remedial plugging are one time outlays which will extend over the life of the well, they can be considered capital expenditures. Assuming an average life of 10 years*, a capital charge rate of 20% per year can be used. These annual capital costs per disposal well must then be divided by the average number of oil wells per injection well and by the average daily production per oil well. Schematically, the calculation looks like this:

$$\frac{\text{(capital expenditure per disposal)} \times \text{(capital charge rate)}}{\text{(365 days year)} \times \text{(average daily production per oil well)} \times \text{(oil wells/disposal well)}}$$

Table A-4 summarizes the results.

The annual capital costs associated with the permit applications and remedial plugging requirements are less than one cent per barrel of oil in the Southwest and only about one and one-half cents per barrel of oil in Appalachia.

Table A-5 presents a comparison of these costs to the estimated costs and revenues per barrel of oil from producing wells in each segment. At most the annual costs are less than four tenths of one percent of the estimated gross margin of the producing wells. Costs of this magnitude are not likely to have any significant impact on oil producers in any of the regions studied.

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* obtained from industry sources

TABLE A-4

Annual Costs for Permit Applications and Remedial Plugging *
($ Per Barrel of Oil)

Southwest					Appalachia
New Primary	Existing Primary	New Secondary	Existing Secondary	Stripper	Stripper
$.003	$.0007	$0.0024	$0.0024	$0.0033	$0.0139

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* Computed According to the formula given in the text as follows:

SOUTHWEST

New Primary: $$\frac{(\$100) \times (0.20)}{(365) \times (20.2) \times (10)}$$

(Note: It was assumed that there are no abandoned wells in a new primary field. Hence, there are no plugging expenditures)

Existing Primary: $$\frac{(\$267) \times (0.20)}{(365) \times (20.2) \times (10)}$$

New Secondary: $$\frac{(\$267) \times (0.20)}{(365) \times (30) \times (2)}$$

Existing Secondary: $$\frac{(\$267) \times (0.20)}{(365) \times (30) \times (20)}$$

Stripper: $$\frac{(\$267) \times (0.20)}{(365) \times (3) \times (15)}$$

APPALACHIA

Stripper: $$\frac{(\$267) \times (0.20)}{(365) \times (0.7) \times (15)}$$

TABLE A-5

Comparison of Annual Capital Costs of Permit Applications and Remedial Plugging with Average Annual Costs and Revenues

	SOUTHWEST					APPALACHIA
	New Primary	Existing Primary	New Secondary	Existing Secondary	Stripper	Stripper
Incremental Annual Costs ($/BBL. Oil)	$.0003	$.0007	$.0024	$.0024	$.0033	$.0139
Percent of Revenue/BBL	.002%	.013%	.018%	.046%	.025%	.107%
Percent of Total Costs/BBL.	.003%	.018%	.035%	.053%	.050%	.155%
Percent of Estimated Gross Margin/BBL.	.014%	.055%	.039%	.353%	.051%	.346%

Annual Costs

The capital expenditure items discussed above, permit applications and remedial plugging, will have no annual operating and maintenance costs. The impact of the annual capital costs has been analyzed above.

The other major item that will result in increased annual costs to operators of oil and gas wells is the prohibition of produced water injection between the annulus of the surface pipe and the production string. This practice is currently allowed only special permission of the appropriate State authorities and, consequently, is rare in most States. In a few States, most notably Ohio (1,674 wells), this practice is more common.

Prohibition of this type of annular injection will require operators of these wells to find alternate methods of produced water disposal. In Ohio many operators have found users for this usually salty water. It is used for dust and ice control on highways, railroad cars, strip mines, and drag strips, for example. Where users of this produced water are not available the most probable alternative for operators would be to hire a waste water disposal company to remove the water. Conversations with the industry on this matter indicate that the costs of removal would be about $35 per truckload of approximately 35-50 barrels of water, or about $1 per barrel.

Wells using annular disposal in the Appalachain area are almost without exception stripper wells. However, in Louisiana and Arkansas, annular injection wells are used in remote locations and for stripper production. The average daily production of stripper wells in 1974 was as follows: Ohio - 1.13 barrels; Louisiana - 1.6 barrels; Arkansas - 3.03 barrels.* The amount of water produced by these wells varies considerably from none in some cases to over 90% in others. A figure of 1 barrel of water produced per well would be a conservative estimate of the average for the States mentioned above. Thus, for the 1,910 wells identified as employing annular injection the total daily production of water would be 1,900 barrels. If we round this figure to 2,000 to allow for other wells which might be practicing annualar injection and assume oil is produced 365 days per year, the total annual cost of disposing of this produced water would be $730,000. From a national point of view this amount is negligible.

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* National Stripper Well Survey as of January 1, 1975; prepared by the Interstate Oil Compact Commission.

Table A-1 indicates that operators of stripper wells realize a gross margin of approximately $6.46 per barrel of oil in the Southwest and $4.02 per barrel of oil in Appalachia. Adding an additional cost of $1 per barrel will significantly detract from this margin, but in the typical case will not cause a well operator to cease production of oil. No significant capital investment would be associated with these additional operating costs, and a substantial margin will remain for the operator. Thus, the typical well will continue to be profitable, and most operators will continue to produce. However, because the economics of stripper well production fluctuates so widely, it is likely that some marginal operators will be forced to close because of the prohibition of annular injection. This number is expected to be very small, however, even on a regional basis. From the national point of view these few closings will certainly be insignificant.

Section B

Municipal and Industrial Injection Wells

TABLE B-1

Standard Industrial Classification of 352 Injection Wells

	Wells	Percentage
Mining (12.8%)		
10 Metal Mining	2	.5
13 Oil and Gas Extraction	36	10.2
14 Non-Metallic Mining	5	1.4
19 Ordnance and Accessories	2	.6
Manufacturing (77.650		
20 Food	7	2.0
26 Paper	3	.9
28 Chemical and Allied Products	180	51.1
29 Petroleum Refining	55	15.6
30 Rubber and Plastics	2	.6
33 Primary Metals	20	5.7
34 Fabricated Metals	1	.3
35 Machinery - Except Electronics	1	.3
36 Electronics	1	.3
38 Photographics	3	.9
Transportation, Gas, and Sanitary Services (7.7%)		
45 Air Transportation	1	.3
49 Electric, Gas and Sanitary Service	25	7.1
55 Auto Dealers and Service Stations	1	.3
Other (1.4%)		
59 Miscellaneous Retail Trade	1	.3
72 Personal Services	1	.3
75 Automobile Repair and Service	1	.3
82 Educational Services	2	.6

Source: Reeder, Louis R.; Review and Assessment of Deep-Well Injection of Hazardous Wastes; EPA, Solid and Hazardous Waste Research Laboratory; 1975.

Cost Estimates

Monitoring

It is assumed that additional monitoring wells will only be required into the nearest fresh water aquifers. Assuming an average depth of approximately 300 feet, these wells would cost approximately $5,000 each (about $16.66 per foot).

Monitoring of the injection zone is assumed to be provided by pressure readings, etc. from the injection well itself.

Stand-by Facilities

The regulations do not make specific requirements regarding stand-by facilities. They specify, however, that a permit must ensure that "adequate plugging," "adequate procedures for detecting failure of the system in a timely fashion," and "adequate contingency plans to cope with malfunction or failure of the underground injection system" are included on a permit. Any change in current state control of these factors will depend upon their interpretation of these Federal guidelines and EPA's approval of these interpretations.

Possible stand-by facilities and programs include (1) lined ponds, (2) tanks, (3) surface treatment plants, (4) stand-by injection wells, and (5) plant shutdown.

The cost of lined ponds or tanks would depend on the number of days capacity defined to be adequate stand-by capability. Table B-2 lists injection rates for deep wells.

TABLE B-2

Average Rate of Injection in Industrial Wells [1/]

Injection Rate	Percent of Wells	
	1967	1972
0 - 50 gpm	27	36
50 - 100	17	13
100 - 200	25	20
200 - 400	26	17
400 - 800	4	7
over 800	1	7

[1/] From Warner, 1972, Ground Water Pollution from Subsurface Excavations, EPA -430/9-73-012, 1973.

Assuming 12 hours per day operation and adequate stand-by capability defined as five days capacity, pond sizes can be determined. Table B-3 shows average costs for lined stand-by ponds. Of course, these would be higher if the plant operated 24 hours per day or needed more than five days of capacity.

TABLE B-3

Costs for Stand-by Lined Ponds 2/

Stand-by capacity (Gallons)	Percent (1972)	Cost ($)
0 - 180,000	36	0 - 2,270
180,000 - 360,000	13	2,270 - 4,210
360,000 - 720,000	20	4,210 - 7,967
720,000 - 1,440,000	17	7,967 - 15,285
1,440,000 - 2,880,000	7	15,285 - 29,665
over 2,880,000	7	over 29,665

Table B-4 contains estimates of stand-by tank costs. These costs far exceed those of stand-by lined ponds. Costs shown are for carbon steel tanks; other tank types may cost two to five times as much. It is assumed that 500,000 gallons is the largest sized tank, and that greater capacities are achieved by using multiple tanks. Intermediate tank sizes are estimated by interpolation.

TABLE B-4

Stand-by Tank Costs

Stand-by Capacity (Gallons)	Percent (1972)	Cost ($)
0 - 180,000	36	0 - 16,000
180,000 - 360,000	13	16,000 - 20,500
360,000 - 720,000	20	20,500 - 41,000
720,000 - 1,440,000	17	41,000 - 70,500
1,440,000 - 2,880,000	7	70,500 - 141,000
over, 2,880,000	7	over 141,000

2/ Assuming: (a) 7.5 gallons/cubic foot, (b) average pond depth of 10 feet, (c) land costs of $300/acre or $.062/sq. yd., (d) construction costs of $10,000/acre or $2.07/sq. yd., (e) lining costs of $2.00/sq. yd. installed, and (f) circular pond floor with vertical walls.

Should interpretation of the regulations require that "adequate contingency plans" consist of a stand-by treatment facility or a stand-by well, cost would be considerably higher. Stand-by treatment facilities may cost about $200,000, while a stand-by well may cost about $250,000. Hence, an operator would be inclined to use ponds where unconstrained by land or regulations.

The stand-by option of plant shutdown cannot be evaluated in this analysis. The opportunity cost would depend upon the physical and financial characteristics of the company and could be quite high.

Injection into Fresh Water Aquifers

The requirement that no deep well injection endanger sources or potential sources of drinking water would apparently prohibit injection into fresh ground water. It is not clear that this prohibition would effect any of the existing wells. Seventy-six percent of existing wells are over 2,000 feet deep. Less than 10 percent are shallower than 1,000 feet. (See Table B-5)

TABLE B-5

Depth of Individual Injection Wells 3/

Total Well Depth (feet)	Percent of Wells 1967	1972	1974
0 - 1,000	7	8	8
1,000 - 2,000	29	16	22
2,000 - 4,000	22	29	25
4,000 - 6,000	31	34	32
6,000 - 12,000	9	12	13
over 12,000	2	1	13

Whether the wells shallower than 1,000 ft (8%) are injecting into sources of drinking water would depend on their location. At $16 per foot the cost of drilling a shallow well 1,000 feet deeper would be $16,000.

Construction Deficiencies

The regulations do not prescribe construction standards. Nevertheless, they do require that information on casing and cementing be included in the application for a permit and that the permit contain a description of appropriate techniques for construction. The States will determine if the proposed casing and cementing will adequately protect ground water.

3/ Source: Warner, 1972; EPA; Op. cit.

It is possible only to estimate if the addition of a formal UIC program to current State control of deep well injection will cause increases in drilling cost due to changes in cementing and casing. Table B-6 lists injection wells by State and Table B-7 details recent legislation. A review of current literature suggests that in most cases construction standards adequately protect drinking water. However, 12 of the States listed had passed no laws through 1972; wells in these States comprise 30 percent of the total shown. It is likely that new laws have been passed since 1972, and that several of the wells were already constructed to high quality standards. Thus, it appears that cost impacts because of the casing and cementing requirements will be minor.

TABLE B-6

Distribution of Existing Industrial and Municipal Wastewater Injection Wells Among the 25 States Having Such Wells in 1975 [4]

Alabama	5
Arkansas	1
California	5
Colorado	2
Florida	7
Hawaii	3
Illinois	6
Indiana	13
Iowa	1
Kansas	30
Kentucky	3
Louisiana	65
Michigan	28
Mississippi	1
Nevada	1
New Mexico	1
New York	4
North Carolina	4
Ohio	9
Oklahoma	14
Pennsylvania	9
Texas	98
Tennessee	3
West Virginia	7
Wyoming	1
TOTAL	322

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[4] Source: Reeder, Louis R.; Review and Assessment of Deep-well Injection of Hazardous Wastes; EPA, Solid and Hazardous Waste Research Laboratory; 1975

TABLE B-7

Recent State Legislation Concerning Wastewater Injection Wells

1961	Texas	Injection well law adopted
1966	Kansas	Regulations adopted
1967	Ohio	Injection well law adopted
	New York	Ground water classified
1969	Indiana	"Test Hole" legislation enacted
	Michigan	"Mineral Well Law" enacted
	New York	Injection well policy established
	Ohio Valley	Regulatory policy recommended
	Texas	1961 law amended
	W. Virginia	Injection well legislation enacted
1970	Illinois	Policy specified
	FWPCA	Policy announced
	Colorado	Rules and regulations for subsurface disposal adopted
1971	Missouri	Disposal wells prohibited
1972	Oklahoma	Regulations adopted
	Council of State Gov'ts	Model State Toxic Waste Disposal Act

Fractured Formations

While the regulations do not impose a limit on injection pressure, this information is required along with any proposed fracturing program on the permit application. Again, it is possible only to estimate if current State limits on injection pressure will become more stringent with EPA involvement, or if more stringent limits will cause additional costs.

Fracturing is a process used to increase dispersion from the well. Basic methods of fracturing are by pumping acid into the well (occasionally under high pressure), high pressure bursts of pumped water, or continuous high pressure pumping. When properly performed, fracturing entails few undesirable environmental impacts. The environmental concern is that the fractures may occasionally extend to other aquifers, resulting in inter-aquifer contamination.

Fracturing occurs at different pressures, depending upon the geologic characteristics of the aquifer. Fracturing may occur at pressures as low as 0.5 psi per foot of well depth, and most aquifers will fracture at pressures of 1.0 psi per foot of well depth.

A review of EPA's 1974 data, summarized in Table B-8 reveals that of the 102 wells that practice or have practiced fracturing, only one (in Oklahoma) practices continuous fracturing. Most of the remainder tend to fracture only when well pressure rises, usually at intervals between a few months and a few years.

TABLE B-8

Fracturing Practices 5/

	No. Wells
Continuous Fracturing	1
Periodic Hydraulic	4
Periodic Acid	88
Periodic Acid and Hydraulic	9
Total No. Fracturing	102
Psi/ft. 0. 5	9

Only nine wells indicated pressures above 0. 5 psi/foot of well depth. These wells (three in Louisiana, two in Michigan, two in Oklahoma, and two in Pennsylvania) ranged in pressure from 0. 52 to 0. 85 psi/ft.

It is unlikely that States will reverse their policies and prohibit fracturing. They may, however, limit pressures. If this happens, the wells affected could meet the standard by increasing the frequency of acid fracturing, drilling deeper (lowering the psi/ft. ratio), or abandoning the well. Assuming that compliance is achieved by drilling deeper, an incremental depth of 1000 feet would cost about $16,000.

5/ Source: Compilation of Industrial and Municipal Injection Wells in the United States, EPA-520/9-74-020, 1974.

SECTION C

State Program Expenditures

The Safe Drinking Water Act of 1974 provides for the States, upon EPA's approval, to assume primary enforcement responsibility for proposed regulations. The following section presents our best estimate of the costs to the States of administering the enforcement program.

Program Coverage

Based upon available data and upon our best professional judgment, the number of underground injection facilities to be covered by this program have been estimated and are presented in Table I.

All conventional wells must be covered under a State permit within five years after the State receives primacy for the UIC program. This will consitute about 113,000 total permits (this includes 87,700 existing facilities and an estimated 25,500 new facilities going into operation during those five years). Each State has the flexibility to choose permit or rule procedures for drainage wells. The choice taken will reflect individual geologic and hydrologic conditions within the State and the effectiveness of the existing State program. Because it is impossible to say exactly what portion of the existing drainage wells will require permits, we have conservatively assumed that one quarter will be permitted. This would result in an additional 12,500 facilities. Thus, the total number of permits to be issued by the States would be approximately 125,000, an average of 25,000 per year.

Current State Authority

A review of existing literature of published water and water pollution laws, solid waste regulations and miscellaneous codes and ordinances indicates that the legal control and procedures regarding ground-water contamination differ widely among States in the scope of activity and compliance monitoring requirements. The effectiveness of State programs is affected by the substantial overlapping jurisdiction and in the assignment of responsibilities to various State agencies. Approximately 25 per cent of the States have statutes dealing specifically with ground-water quality. However, all States possess some authority which enables them to initiate action, if necessary, to protect ground water.

Control of underground injection activities is usually divided between two or more State agencies which may function independently of, or in conjunction with, each other. The types of agencies involved include State Geological Surveys, Environmental Protection Agencies, Water Quality Boards, Health Departments, Oil and Gas Commissions, and Departments of Natural Resources.

Furthermore, the extent of control of various underground injection practices vary. Most States have a permit program for industrial and municipal disposal wells, and brine disposal and secondary recovery wells. Control of other injection practices range from no control, rule procedures, or permits.

State Program Requirements for Implementation

Section 1422(a) of the Safe Drinking Water Act requires the Administrator to list in the Federal Register those States for which, in his judgment, a State underground injection control program may be necessary to assure that present and potential drinking water sources are protected.

The following assumptions and statutory requirements generated the resource requirement for implementation:

- EPA would list all 50 States, territories and jurisdictions at once as requiring UIC programs.

- Permits would be required for all new conventional wells and engineering wells* which approximate 50 each year. Five years would be allowed to permit the 17,700 existing wells. Of these the 14,500 gas storage wells, which comprise only 338 storage systems, would be permitted as parts of systems thus requiring much less work per permit. Only 1,000 permit equivalents would be necessary. This would reduce the total of 17,700 existing conventional well permits to 4,200.

- Five years would be allowed to permit the 10,000 oil and gas field disposal wells and the 60,000 oil and gas secondary recovery wells. Permits for new wells would total 1,000 per year for disposal wells, and 4,000 per year for secondary recovery wells.

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* Includes industrial and municipal injection wells, subsidence control wells, barrier wells, recharge wells, geothermal wells, solution mining wells, and gas storage wells.

Personnel Requirements for a
Model State Ground Water Protection Program

	Disposal Wells	Oil and Gas, Secondary Recovery Wells	Drainage Wells[1]	Recharge Wells	Mining
Senior Professionals	5md/well	6md/5 projects	7md/10^6 pop	4md/system	7md/10 mine
Professionals	19md/well	27md/5 projects	15md/10^6 pop	14md/system	35md/10 mine
Clerical	2md/well	6md/5 projects	10md/10^6 pop	4md/system	7md/10 mine

Abbreviations: md = man days
10^6 = million people

Source: A Manual of Laws, Regulations, and Institutions for Control of Ground Water Pollution; National Water Well Association; Worthington, Ohio; 1976.

1) Requirements from original reference have been cut in half because the NWWA estimate is for a permit program and the UIC program gives the States an option of permit or rule.

Underground Injection Control Program
An Estimate of Total State rsonnel Requirements

	Disposal Wells	Oil & Gas Secondary Recovery Wells	Drainage Wells	Recharge Wells	Solution Mining Wells	Total
Units/year[1]	4,000 wells	3,200 projects	220×10^6 pop	20 systems	100 mines	
Personnel Requirements[2]						
Senior Professional	83	16	6	-	-	105
Professional	317	72	14	1	1	405
Clerical	33	16	9	1	1	60
Total	433	104	29	2	2	570
Annual Expenditures[3] ($ million)						
Senior Professional	$3.38	$0.65	$0.24	-	-	$4.3
Professional	7.04	1.60	0.31	$0.02	$0.02	9.0
Clerical	0.40	0.19	0.11	0.01	0.01	0.7
Total	$10.82	$2.44	$0.66	$0.03	$0.03	$14.0

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1) Disposal wells include conventional wells and engineering wells plus oil and gas field disposal wells less recharge wells and solution mining wells. The 14,500 gas storage wells have been adjusted to 1,000 permit equivalents.
2) From Table C-1.
3) Assuming annual summaries of $22,000 for senior professionals; $12,000 for professionals (includes junior engineers and lawyers, and technicians) and $6,500 for clerical. All salaries have been multiplied by 1.85 to provide all allowance for overhead costs (i.e., billings, supplies, fringe benefits, etc.).

. States would have the option to control the approximately 50,000 drainage wells by rule or permit. One quarter of these would be regulated by permit.

Thus, the total number of permits issued each year would be a maximum of 25,000.

No detailed work has been done to estimate the numbers of additional personnl, etc. that will be required by each State to implement the proposed program. However, some studies have been done which allow us to make a reasonable estimate of the approximate level of expenditures that can be expected.

In making these estimates it must be kept in mind that most States already have in operation permit program similar to that proposed in these regulations. Thus, a distinction must be made between the total costs of the proposed program and the incremental costs, that is, costs created by the proposed regulations which are above the costs already being incurred by the States. It is only the incremental costs that can be considered to be the true costs of the proposed regulations.

The first study that can be used to estimate State program expenditures is a "A Manual of Laws, Regulations and Institutions for Control of Ground Water Pollution" prepared by the National Water Well Association. In this study, personnel requirements have been estimated for a model State ground-water protection program. Personnel requirements for those portions of the model program which deal with the underground injection facilities covered by the proposed regulations are summarized in Table C-1. Table C-2 uses these estimates to project the total personnel and the associated annual expenditures to administer the model program given our previous assumptions about the number of permits required.

Using this method of analysis, a total of approximately 570 personnel would be needed to administer the State programs, an average of 11 people per State. Total costs using the assumptions about State personnel and overhead costs presented in Table C-2 would be approximately $14.0 million per year. It should be noted that these figures are estimates of the total costs of implementing the proposed regulations, not the incremental costs which are the object of this analysis. The current level of expenditures being made by the States has yet to be deducted from these total costs. This will be dealt with shortly.

It should also be noted that the personnel requirements prepared by the National Water Well Association were for a "model State ground-water protection program." This program differs substantially from the proposed regulations. In general, it is much more strict. Thus, the personnel and expenditure estimates derived above are likely to be much higher than those associated with the proposed regulations. These estimates, then, can be regarded as very conservative.

Another study that can be used to indicate the probable level of expenditures to be expected from the proposed regulations is currently being completed by EPA. This study, a Manpower Planning Criteria Manual for State Water Pollution Control Agencies*, does not deal specifically with a ground-water protection program. However, the study does provide estimates of administering the national pollution discharge elimination system permit program. This permit program is a much more complicated program than that which would be required by these regulations since it is concerned with permitting effluents from municipal and industrial establishments, most of which have never been the subject of a permit program. Using the estimating procedures of this study, therefore, should provide an upper range for the costs of the State programs associated with the proposed regulations.

The EPA study provides an estimate of the man-years per permit issued that would be required to administer the subject program. Assuming a total requirement of approximatecly 25,000 permits per year, or an average of 500 per State, the appropriate work load factor from the EPA study would be 0.025 man-years per permit issued.* This would result in a total annual personnel requirement of approximately 625.** This estimate of the total requirements of the proposed program is of the same order of magnitude as the previous estimate, and adds some confirmation to our methodology. If the total costs of the previous estimates are increased by the same proportion as this estimate's personnel increase, a new estimate of total costs of $15.3 million would result.

The above two estimates of the total costs of the State programs associated with the proposed regulations provide a range of $14.0 million to $15.3 million. For the reasons stated above, both of these estimates can be regarded as very conservative estimates. Thus, a rounded figure of $14.6 million per year might be considered as a reasonable estimate of the maximum total costs of the State programs.

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* Report No. 2 of the Study of Manpower Needs for Implementation of the Water Pollution Control Act Amendments of 1972 - Draft; USEPA; November 1975.

** 25,000 x 0.025

This total cost estimate must be adjusted by the level of expenditures already being incurred by the States in administering programs that would be included within the programs required by the proposed regulations. Most States already have underground injection control programs, many of which are very similar to the proposed programs. The thirty-two States with oil and gas wells, for example, all have programs controlling wells in this category. Similarly, the twenty-seven States with industrial or municipal injection wells have programs regulating these wells. Most of these regulatory programs are well staffed. Texas, for example, has over 60 people engaged in reglating oil and gas wells and an additional 32 people concerned with other injection well categories. In Florida, it is estimated that 50-60 people are engaged full time in underground injection control activities.

Other categories of injection or disposal wells are less well regulated at present. Very few States, for example have programs for regulating drainage wells. The existence of an estimated 2,000 supposedly prohibited industrial and municipal shallow disposal wells indicates that State regulatory programs in this area are deficient.

Thus, from a brief look at existing State underground injection control programs it can be seen that, although the current level of State expenditures will certainly have to be augmented, much of the total requirements are already being expended.

In an informal survey conducted in conjunction with a previous and much more comprehensive verision of the proposed regulations, the States of Pennsylvania, Florida, Michigan, Kansas and Texas indicates that in general they would have to at least double their staff and budget requirements to administer the proposed programs. Because considerably more facilities were included in the regulations at that time, this estimate of doubling State resource requirements can be regarded as an upper estimate of the actual program costs.

Using this figure and the above calculated total program costs of $14. 6 million, yields a macimum estimate for the incremental State program costs associated with the proposed regulations of $7. 3 million. Because of extensive State commitments already existing in this area and because of our conservative estimating procedures, this figure regarded as probably very high, but it at least provides us with an order of magnitude estimate of what the actual incremental costs will be.

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